

Virtual Consultant

~~A SYSTEM METHOD AND ARTICLE OF MANUFACTURE FOR  
CREATING A VIRTUAL CONSULTANT~~

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**FIELD OF THE INVENTION**

- 5 The present invention relates to education systems and more particularly to a rule based tutorial system that utilizes a virtual consultant.

**BACKGROUND OF THE INVENTION**

- 10 When building a knowledge based system or expert system, at least two disciplines are necessary to properly construct the rules that drive the knowledge base, the discipline of the knowledge engineer and the knowledge of the expert. The domain expert has knowledge of the domain or field of use of the expert system. For example, the domain expert of an expert for instructing students in an automotive manufacturing facility might be a process control engineer while the domain expert
- 15 for a medical instruction system might be a doctor or a nurse. The knowledge engineer is a person that understands the expert system and utilizes the expert's knowledge to create an application for the system. In many instances, the knowledge engineer and domain expert are separate people who have to collaborate to construct the expert system.

- 20 Typically, this collaboration takes the form of the knowledge engineer asking questions of the domain expert and incorporating the answers to these questions into the design of the system. This approach is labor intensive, slow and error prone. The coordination of the two separate disciplines may lead to problems. Although
- 25 the knowledge engineer can transcribe input from the expert utilizing videotape, audio tape, text and other sources, efforts from people of both disciplines have to be expended. Further, if the knowledge engineer does not ask the right questions or asks the questions in an incorrect way, the information utilized to design the knowledge base could be incorrect. Feedback to the knowledge engineer from the
- 30 expert system is often not available in prior art system until the construction is

completed. With conventional system, there is a time consuming feedback loop that ties together various processes from knowledge acquisition to validation.

5 Educational systems utilizing an expert system component often suffer from a lack of motivational aspects that result in a user becoming bored or ceasing to complete a training program. Current training programs utilize static, hard-coded feedback with some linear video and graphics used to add visual appeal and illustrate concepts. These systems typically support one "correct" answer and navigation through the system is only supported through a single defined path which results in a two-  
10 dimensional generic interaction, with no business model support and a single feedback to the learner of correct or incorrect based on the selected response. Current tutorial systems do not architect real business simulations into the rules to provide a creative learning environment to a user.

### 15 SUMMARY OF THE INVENTION

According to a broad aspect of a preferred embodiment of the invention, a goal based learning system utilizes a rule based expert training system to provide a cognitive educational experience.

20 A system is disclosed that provides a goal based learning system utilizing a rule based expert training system to provide a cognitive educational experience. The system provides the user with a simulated environment that presents a training opportunity to understand and solve optimally. A system is disclosed that provides a goal based learning system utilizing a rule based expert training system to provide a  
25 cognitive educational experience. The system provides a user with a simulated environment that presents a training opportunity to understand and solve optimally. The technique establishes a virtual consultant by connecting a virtual university server and one or more users, selects a destination within the virtual university server to interact with the one or more users, couples the one or more users through  
30 the virtual university server based on the selected destination, and establishes interaction parameters for the one or more users based on the selected destination.

The interaction techniques include rules for one to one correspondence and one to many. The destinations include a virtual classroom, administrative offices, virtual library and virtual student union. Additional support is provided for distributing grades, tests, homework materials, directory information and other classroom materials electronically.

### DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, aspects and advantages are better understood from the following detailed description of a preferred embodiment of the invention with reference to the drawings, in which:

Figure 1 is a block diagram of a representative hardware environment in accordance with a preferred embodiment;

Figure 2 is a block diagram of a system architecture in accordance with a preferred embodiment;

Figure 3 depicts the timeline and relative resource requirements for each phase of development for a typical application development in accordance with a preferred embodiment;

Figure 4 depicts the potential savings in both functional and technical tasks in accordance with a preferred embodiment;

Figure 5 illustrates commonalties in accordance with a preferred embodiment;

Figure 6 illustrates a development architecture approach in accordance with a preferred embodiment;

Figure 7 illustrates a small segment of a domain model for claims handlers in the auto insurance industry in accordance with a preferred embodiment;

Figure 8 illustrates an instantiated domain model in accordance with a preferred embodiment;

- 5 Figure 9 illustrates an insurance underwriting profile in accordance with a preferred embodiment;

Figure 10 illustrates a transformation component in accordance with a preferred embodiment;

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Figure 11 illustrates the use of a toolbar to navigate and access application level features in accordance with a preferred embodiment;

Figure 12 is a GBS display in accordance with a preferred embodiment;

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Figure 13 is a feedback display in accordance with a preferred embodiment;

Figure 14 illustrates a display in which a student has made some mistakes in accordance with a preferred embodiment;

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Figure 15 illustrates a journal entry simulation in accordance with a preferred embodiment;

- 25 Figure 16 illustrates a simulated Bell Phone Bill journal entry in accordance with a preferred embodiment;

Figure 17 illustrates a feedback display in accordance with a preferred embodiment;

- 30 Figures 18 and 19 illustrate a feedback display in accordance with a preferred embodiment;

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Figure 20 illustrates a feedback display in accordance with a preferred embodiment;

Figure 21 illustrates a simulation display in accordance with a preferred embodiment;

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Figure 22 illustrates the steps of the first scenario in accordance with a preferred embodiment;

Figure 23 and 24 illustrate the steps associated with a build scenario in accordance with a preferred embodiment;

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Figure 25 illustrates how the tool suite supports student administration in accordance with a preferred embodiment;

Figure 26 illustrates a suite to support a student interaction in accordance with a preferred embodiment;

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Figure 27 illustrates the remediation process in accordance with a preferred embodiment;

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Figure 28 illustrates a display of journalization transactions in accordance with a preferred embodiment;

Figure 29 illustrates the objects for the journalization task in accordance with a preferred embodiment;

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Figure 30 illustrates the mapping of a source item to a target item in accordance with a preferred embodiment;

Figure 31 illustrates target group bundles in accordance with a preferred embodiment;

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Figure 32 illustrates a TargetGroup Hierarchy in accordance with a preferred embodiment;

- 5 Figure 33 illustrates a small section the amount of feedback in accordance with a preferred embodiment;

Figure 34 illustrates an analysis of rules in accordance with a preferred embodiment;

- 10 Figure 35 illustrates a feedback selection in accordance with a preferred embodiment;

Figure 36 is a flowchart of the feedback logic in accordance with a preferred embodiment;

- Figure 37 illustrates an example of separating out some mistakes for the interface to catch and others for the ICAT to catch has positive and negative impacts in accordance with a preferred embodiment;

- 20 Figure 38 is a block diagram of the hierarchical relationship of a transaction in accordance with a preferred embodiment;

Figure 39 is a block diagram illustrating the feedback hierarchy in accordance with a preferred embodiment;

- 25 Figure 40 is a block diagram illustrating how the simulation engine is architected into a preferred embodiment of the invention;

- Figure 41 is a block diagram setting forth the architecture of a simulation model in  
30 accordance with a preferred embodiment;

Figure 43 illustrates a drag & drop input operation in accordance with a preferred embodiment;

Figure 44 illustrates list object processing in accordance with a preferred embodiment;

Figure 45 illustrates the steps for configuring a simulation in accordance with a preferred embodiment;

Figure 46 illustrates a distinct output in accordance with a preferred embodiment;

Figure 47 is a block diagram presenting the detailed architecture of a system dynamics model in accordance with a preferred embodiment;

Figure 48 is graphical representation of the object model which is utilized to instantiate the system dynamic engine in accordance with a preferred embodiment.

Figure 49 is a PInput Cell for a simulation model in accordance with a preferred embodiment;

Figure 50 is a PInput backup cell in a simulation model in accordance with a preferred embodiment;

Figure 51 is a display illustrating a POutput cell in accordance with a preferred embodiment. The steps required to configure the POutput are presented below;

Figure 52 is an overview diagram of the logic utilized for initial configuration in accordance with a preferred embodiment;

Figure 53 is a display of the source item and target configuration in accordance with a preferred embodiment;

5 Figure 54 is a display of video information in accordance with a preferred embodiment;

Figure 55 illustrates a display depicting configured rules in accordance with a preferred embodiment;

10 Figure 56 illustrates feedback for configured rules in accordance with a preferred embodiment;

Figure 57 illustrates a display with follow-up configuration questions in accordance with a preferred embodiment;

15 Figure 58 illustrates configuration of aggregate rules in accordance with a preferred embodiment;

Figure 59 illustrates a set of coach items in accordance with a preferred embodiment;

20 Figure 60 is an ICA Meeting Configuration tool display in accordance with a preferred embodiment;

Figure 61 illustrates an ICA utility in accordance with a preferred embodiment;

25 Figure 62 illustrates a configuration utility display in accordance with a preferred embodiment;

30 Figure 63 illustrates an object editor toolbar in accordance with a preferred embodiment;

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Figure 74 is an object editor display that illustrates the use of references in accordance with a preferred embodiment;

Figure 75 presents the detailed design of smart spreadsheets in accordance with a preferred embodiment;

Figure 76 presents the assembly of a telephone operator training simulation in accordance with a preferred embodiment;

Figure 77 presents the domain expert's work station utilized to assemble a simulation in accordance with a preferred embodiment;

Figure 78 presents multiple domain expert's work stations linked/networked to collaborate on the assembly of a simulation in accordance with a preferred embodiment;

Figure 79 presents the detailed flowchart of a telephone operator training simulation in accordance with a preferred embodiment;

Figure 80 presents a user training station linked/networked to the simulation server in accordance with a preferred embodiment;

Figure 81 presents a detailed flowchart of a user query of the knowledge base in accordance with a preferred embodiment;

Figure 82 presents an example of feedback from a coach in accordance with a preferred embodiment;

Figure 83 presents multiple user's training stations linked/networked to collaborate in the execution of a simulation in accordance with a preferred embodiment;

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Figure 84 is a block diagram of a system environment in accordance with a preferred embodiment;

Figure 85 is a block diagram of a virtual consulting channel in accordance with a  
5 preferred embodiment;

Figures 86 and 87 are data structures for a virtual consulting environment in accordance with a preferred embodiment; and

10 Figures 88 – 99 are flowcharts of a virtual university system in accordance with a preferred embodiment.

#### DETAILED DESCRIPTION

15 A preferred embodiment of a system in accordance with the present invention is preferably practiced in the context of a personal computer such as an IBM compatible personal computer, Apple Macintosh computer or UNIX based workstation. A representative hardware environment is depicted in Figure 1, which illustrates a typical hardware configuration of a workstation in accordance with a  
20 preferred embodiment having a central processing unit 110, such as a microprocessor, and a number of other units interconnected via a system bus 112. The workstation shown in Figure 1 includes a Random Access Memory (RAM) 114, Read Only Memory (ROM) 116, an I/O adapter 118 for connecting peripheral devices such as disk storage units 120 to the bus 112, a user interface adapter 122 for  
25 connecting a keyboard 124, a mouse 126, a speaker 128, a microphone 132, and/or other user interface devices such as a touch screen (not shown) to the bus 112, communication adapter 134 for connecting the workstation to a communication network (e.g., a data processing network) and a display adapter 136 for connecting the bus 112 to a display device 138. The workstation typically has resident thereon  
30 an operating system such as the Microsoft Windows NT or Windows/95 Operating System (OS), the IBM OS/2 operating system, the MAC OS, or UNIX operating

system. Those skilled in the art will appreciate that the present invention may also be implemented on platforms and operating systems other than those mentioned.

5 A preferred embodiment is written using JAVA, C, and the C++ language and utilizes object oriented programming methodology. Object oriented programming (OOP) has become increasingly used to develop complex applications. As OOP moves toward the mainstream of software design and development, various software solutions require adaptation to make use of the benefits of OOP. A need exists for these principles of OOP to be applied to a messaging interface of an electronic  
10 messaging system such that a set of OOP classes and objects for the messaging interface can be provided.

OOP is a process of developing computer software using objects, including the steps of analyzing the problem, designing the system, and constructing the program. An  
15 object is a software package that contains both data and a collection of related structures and procedures. Since it contains both data and a collection of structures and procedures, it can be visualized as a self-sufficient component that does not require other additional structures, procedures or data to perform its specific task. OOP, therefore, views a computer program as a collection of largely autonomous  
20 components, called objects, each of which is responsible for a specific task. This concept of packaging data, structures, and procedures together in one component or module is called encapsulation.

In general, OOP components are reusable software modules that present an interface  
25 that conforms to an object model and which are accessed at run-time through a component integration architecture. A component integration architecture is a set of architecture mechanisms which allow software modules in different process spaces to utilize each others capabilities or functions. This is generally done by assuming a common component object model on which to build the architecture. It is  
30 worthwhile to differentiate between an object and a class of objects at this point. An object is a single instance of the class of objects, which is often just called a class. A

class of objects can be viewed as a blueprint, from which many objects can be formed.

5 OOP allows the programmer to create an object that is a part of another object. For example, the object representing a piston engine is said to have a composition-relationship with the object representing a piston. In reality, a piston engine comprises a piston, valves and many other components; the fact that a piston is an element of a piston engine can be logically and semantically represented in OOP by two objects.

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OOP also allows creation of an object that “depends from” another object. If there are two objects, one representing a piston engine and the other representing a piston engine wherein the piston is made of ceramic, then the relationship between the two objects is not that of composition. A ceramic piston engine does not make up a  
15 piston engine. Rather it is merely one kind of piston engine that has one more limitation than the piston engine; its piston is made of ceramic. In this case, the object representing the ceramic piston engine is called a derived object, and it inherits all of the aspects of the object representing the piston engine and adds further limitation or detail to it. The object representing the ceramic piston engine  
20 “depends from” the object representing the piston engine. The relationship between these objects is called inheritance.

When the object or class representing the ceramic piston engine inherits all of the aspects of the objects representing the piston engine, it inherits the thermal  
25 characteristics of a standard piston defined in the piston engine class. However, the ceramic piston engine object overrides these ceramic specific thermal characteristics, which are typically different from those associated with a metal piston. It skips over the original and uses new functions related to ceramic pistons. Different kinds of piston engines have different characteristics, but may have the same underlying  
30 functions associated with it (e.g., how many pistons in the engine, ignition sequences, lubrication, etc.). To access each of these functions in any piston engine

object, a programmer would call the same functions with the same names, but each type of piston engine may have different/overriding implementations of functions behind the same name. This ability to hide different implementations of a function behind the same name is called polymorphism and it greatly simplifies  
5 communication among objects.

With the concepts of composition-relationship, encapsulation, inheritance and polymorphism, an object can represent just about anything in the real world. In fact, our logical perception of the reality is the only limit on determining the kinds of  
10 things that can become objects in object-oriented software. Some typical categories are as follows:

- Objects can represent physical objects, such as automobiles in a traffic-flow simulation, electrical components in a circuit-design program, countries in an economics model, or aircraft in an air-traffic-control system.
- 15 • Objects can represent elements of the computer-user environment such as windows, menus or graphics objects.
- An object can represent an inventory, such as a personnel file or a table of the latitudes and longitudes of cities.
- An object can represent user-defined data types such as time, angles, and  
20 complex numbers, or points on the plane.

With this enormous capability of an object to represent just about any logically separable matters, OOP allows the software developer to design and implement a computer program that is a model of some aspects of reality, whether that reality is a  
25 physical entity, a process, a system, or a composition of matter. Since the object can represent anything, the software developer can create an object which can be used as a component in a larger software project in the future.

If 90% of a new OOP software program consists of proven, existing components  
30 made from preexisting reusable objects, then only the remaining 10% of the new software project has to be written and tested from scratch. Since 90% already came

from an inventory of extensively tested reusable objects, the potential domain from which an error could originate is 10% of the program. As a result, OOP enables software developers to build objects out of other, previously built objects.

- 5 This process closely resembles complex machinery being built out of assemblies and sub-assemblies. OOP technology, therefore, makes software engineering more like hardware engineering in that software is built from existing components, which are available to the developer as objects. All this adds up to an improved quality of the software as well as an increased speed of its development.

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Programming languages are beginning to fully support the OOP principles, such as encapsulation, inheritance, polymorphism, and composition-relationship. With the advent of the C++ language, many commercial software developers have embraced OOP. C++ is an OOP language that offers a fast, machine-executable code.

- 15 Furthermore, C++ is suitable for both commercial-application and systems-programming projects. For now, C++ appears to be the most popular choice among many OOP programmers, but there is a host of other OOP languages, such as Smalltalk, Common Lisp Object System (CLOS), and Eiffel. Additionally, OOP capabilities are being added to more traditional popular computer programming
- 20 languages such as Pascal.

The benefits of object classes can be summarized, as follows:

- Objects and their corresponding classes break down complex programming problems into many smaller, simpler problems.
- 25 • Encapsulation enforces data abstraction through the organization of data into small, independent objects that can communicate with each other. Encapsulation protects the data in an object from accidental damage, but allows other objects to interact with that data by calling the object's member functions and structures.
- 30 • Subclassing and inheritance make it possible to extend and modify objects through deriving new kinds of objects from the standard classes available in

the system. Thus, new capabilities are created without having to start from scratch.

- Polymorphism and multiple inheritance make it possible for different programmers to mix and match characteristics of many different classes and create specialized objects that can still work with related objects in predictable ways.
- Class hierarchies and containment hierarchies provide a flexible mechanism for modeling real-world objects and the relationships among them.
- Libraries of reusable classes are useful in many situations, but they also have some limitations. For example:
  - Complexity. In a complex system, the class hierarchies for related classes can become extremely confusing, with many dozens or even hundreds of classes.
  - Flow of control. A program written with the aid of class libraries is still responsible for the flow of control (i.e., it must control the interactions among all the objects created from a particular library). The programmer has to decide which functions to call at what times for which kinds of objects.
  - Duplication of effort. Although class libraries allow programmers to use and reuse many small pieces of code, each programmer puts those pieces together in a different way. Two different programmers can use the same set of class libraries to write two programs that do exactly the same thing but whose internal structure (i.e., design) may be quite different, depending on hundreds of small decisions each programmer makes along the way. Inevitably, similar pieces of code end up doing similar things in slightly different ways and do not work as well together as they should.

Class libraries are very flexible. As programs grow more complex, more programmers are forced to reinvent basic solutions to basic problems over and over again. A relatively new extension of the class library concept is to have a framework of class libraries. This framework is more complex and consists of significant collections of collaborating classes that capture both the small scale

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framework carries the event loop concept further. Instead of dealing with all the nuts and bolts of constructing basic menus, windows, and dialog boxes and then making these things all work together, programmers using application frameworks start with working application code and basic user interface elements in place.

- 5 Subsequently, they build from there by replacing some of the generic capabilities of the framework with the specific capabilities of the intended application.

Application frameworks reduce the total amount of code that a programmer has to write from scratch. However, because the framework is really a generic application  
10 that displays windows, supports copy and paste, and so on, the programmer can also relinquish control to a greater degree than event loop programs permit. The framework code takes care of almost all event handling and flow of control, and the programmer's code is called only when the framework needs it (e.g., to create or manipulate a proprietary data structure).

- 15 A programmer writing a framework program not only relinquishes control to the user (as is also true for event loop programs), but also relinquishes the detailed flow of control within the program to the framework. This approach allows the creation of more complex systems that work together in interesting ways, as opposed to  
20 isolated programs, having custom code, being created over and over again for similar problems.

Thus, as is explained above, a framework basically is a collection of cooperating classes that make up a reusable design solution for a given problem domain. It  
25 typically includes objects that provide default behavior (e.g., for menus and windows), and programmers use it by inheriting some of that default behavior and overriding other behavior so that the framework calls application code at the appropriate times.

- 30 There are three main differences between frameworks and class libraries:

- Behavior versus protocol. Class libraries are essentially collections of behaviors that you can call when you want those individual behaviors in your program. A framework, on the other hand, provides not only behavior but also the protocol or set of rules that govern the ways in which behaviors can be combined, including rules for what a programmer is supposed to provide versus what the framework provides.
  - Call versus override. With a class library, the code the programmer instantiates objects and calls their member functions. It's possible to instantiate and call objects in the same way with a framework (i.e., to treat the framework as a class library), but to take full advantage of a framework's reusable design, a programmer typically writes code that overrides and is called by the framework. The framework manages the flow of control among its objects. Writing a program involves dividing responsibilities among the various pieces of software that are called by the framework rather than specifying how the different pieces should work together.
  - Implementation versus design. With class libraries, programmers reuse only implementations, whereas with frameworks, they reuse design. A framework embodies the way a family of related programs or pieces of software work. It represents a generic design solution that can be adapted to a variety of specific problems in a given domain. For example, a single framework can embody the way a user interface works, even though two different user interfaces created with the same framework might solve quite different interface problems.
- Thus, through the development of frameworks for solutions to various problems and programming tasks, significant reductions in the design and development effort for software can be achieved. A preferred embodiment of the invention utilizes HyperText Markup Language (HTML) to implement documents on the Internet together with a general-purpose secure communication protocol for a transport medium between the client and the Newco. HTTP or other protocols could be readily substituted for HTML without undue experimentation. Information on these

products is available in T. Berners-Lee, D. Connolly, "RFC 1866: Hypertext Markup Language - 2.0" (Nov. 1995); and R. Fielding, H. Frystyk, T. Berners-Lee, J. Gettys and J.C. Mogul, "Hypertext Transfer Protocol -- HTTP/1.1: HTTP Working Group Internet Draft" (May 2, 1996). HTML is a simple data format used to create

5   hypertext documents that are portable from one platform to another. HTML documents are SGML documents with generic semantics that are appropriate for representing information from a wide range of domains. HTML has been in use by the World-Wide Web global information initiative since 1990. HTML is an application of ISO Standard 8879; 1986 Information Processing Text and Office  
10   Systems; Standard Generalized Markup Language (SGML).

To date, Web development tools have been limited in their ability to create dynamic Web applications which span from client to server and interoperate with existing computing resources. Until recently, HTML has been the dominant technology used  
15   in development of Web-based solutions. However, HTML has proven to be inadequate in the following areas:

- Poor performance;
- Restricted user interface capabilities;
- Can only produce static Web pages;
- 20   •       Lack of interoperability with existing applications and data; and
- Inability to scale.

Sun Microsystem's Java language solves many of the client-side problems by:

- Improving performance on the client side;
- 25   •       Enabling the creation of dynamic, real-time Web applications; and
- Providing the ability to create a wide variety of user interface components.

With Java, developers can create robust User Interface (UI) components. Custom "widgets" (e.g., real-time stock tickers, animated icons, etc.) can be created, and  
30   client-side performance is improved. Unlike HTML, Java supports the notion of client-side validation, offloading appropriate processing onto the client for improved

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performance. Dynamic, real-time Web pages can be created. Using the above-mentioned custom UI components, dynamic Web pages can also be created.

Sun's Java language has emerged as an industry-recognized language for  
5 "programming the Internet." Sun defines Java as: "a simple, object-oriented,  
distributed, interpreted, robust, secure, architecture-neutral, portable, high-  
performance, multithreaded, dynamic, buzzword-compliant, general-purpose  
programming language. Java supports programming for the Internet in the form of  
platform-independent Java applets." Java applets are small, specialized applications  
10 that comply with Sun's Java Application Programming Interface (API) allowing  
developers to add "interactive content" to Web documents (e.g., simple animations,  
page adornments, basic games, etc.). Applets execute within a Java-compatible  
browser (e.g., Netscape Navigator) by copying code from the server to client. From  
a language standpoint, Java's core feature set is based on C++. Sun's Java literature  
15 states that Java is basically, "C++ with extensions from Objective C for more  
dynamic method resolution."

Another technology that provides similar function to JAVA is provided by Microsoft  
and ActiveX Technologies, to give developers and Web designers wherewithal to  
20 build dynamic content for the Internet and personal computers. ActiveX includes tools  
for developing animation, 3-D virtual reality, video and other multimedia content. The  
tools use Internet standards, work on multiple platforms, and are being supported by  
over 100 companies. The group's building blocks are called ActiveX Controls, small,  
fast components that enable developers to embed parts of software in hypertext  
25 markup language (HTML) pages. ActiveX Controls work with a variety of  
programming languages including Microsoft Visual C++, Borland Delphi, Microsoft  
Visual Basic programming system and, in the future, Microsoft's development tool for  
Java, code named "Jakarta." ActiveX Technologies also includes ActiveX Server  
Framework, allowing developers to create server applications. One of ordinary skill in  
30 the art readily recognizes that ActiveX could be substituted for JAVA without undue  
experimentation to practice the invention.

A simulation engine in accordance with a preferred embodiment is based on a Microsoft Visual Basic component developed to help design and test feedback in relation to a Microsoft Excel spreadsheet. These spreadsheet models are what  
5 simulate actual business functions and become a task that will be performed by a student. The Simulation Engine accepts simulation inputs and calculates various outputs and notifies the system of the status of the simulation at a given time in order to obtain appropriate feedback.

### Relationship of Components

10 The simulation model executes the business function that the student is learning and is therefore the center point of the application. An activity 'layer' allows the user to visually guide the simulation by passing inputs into the simulation engine and receiving an output from the simulation model. For example, if the student was working on an income statement activity, the net sales and cost of goods sold  
15 calculations are passed as inputs to the simulation model and the net income value is calculated and retrieved as an output. As calculations are passed to and retrieved from the simulation model, they are also passed to the Intelligent Coaching Agent (ICA). The ICA analyzes the Inputs and Outputs to the simulation model and generates feedback based on a set of rules. This feedback is received and displayed  
20 through the Visual Basic Architecture.

Figure 2 is a block diagram of a system architecture in accordance with a preferred embodiment. The Presentation 'layer' 210 is separate from the activity 'layer' 220 and communication is facilitated through a set of messages 230 that control the  
25 display specific content topics. A preferred embodiment enables knowledge workers 200 & 201 to acquire complex skills rapidly, reliably and consistently across an organization to deliver rapid acquisition of complex skills. This result is achieved by placing individuals in a simulated business environment that "looks and feels" like real work, and challenging them to make decisions which support a business'  
30 strategic objectives utilizing highly effective learning theory (e.g., goal based learning, learn by doing, failure based learning, etc.), and the latest in multimedia

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30 by a very open-ended environment, where students can go through the application

along any number of paths, depending on their learning style and prior experiences/knowledge.

5 A category of learning approaches called Learn by Doing, is commonly used as a solution to support the first phase (Learn) of the Workforce Performance Cycle. However, it can also be a solution to support the second phase (Perform) of the cycle to enable point of need learning during job performance. By adopting the approach presented, some of the benefits of a technology based approach for building business simulation solutions which create more repeatable, predictable projects resulting in  
10 more perceived and actual user value at a lower cost and in less time are highlighted.

Most corporate training programs today are misdirected because they have failed to focus properly on the purpose of their training. These programs have confused the memorization of facts with the ability to perform tasks; the knowing of "that" with  
15 the knowing of "how". By adopting the methods of traditional schools, businesses are teaching a wide breadth of disconnected, decontextualized facts and figures, when they should be focused on improved performance. How do you teach performance, when lectures, books, and tests inherently are designed around facts and figures? Throw away the lectures, books, and tests. The best way to prepare for  
20 high performance is to perform; experience is the best teacher! Most business leaders agree that workers become more effective the more time they spend in their jobs. The best approach for training novice employees, therefore, would be letting them learn on the job, acquiring skills in their actual work environment. The idea of learning-by-doing is not revolutionary, yet it is resisted in business and academia.  
25 Why is this so, if higher competence is universally desired?

Learners are reluctant to adopt learning-by-doing because they are frightened of failure. People work hard *to avoid making mistakes in front of others*. Business leaders are hesitant to implement learning-by-doing because novice failure may have  
30 dramatic safety, legal and financial implications. Imagine a novice pilot learning-by-doing as he accelerates a large jet plane down a runway; likewise, consider a new

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financial analyst learning-by-doing as he structures a multi-million dollar financial loan. Few employers are willing to endure such failures to have a more competent workforce.

- 5 The concerns of employee and employer can be relieved if the training (and accompanying failure) didn't occur in front of co-workers and clients, if it didn't jeopardize a multi-million dollar aircraft or a multi-million dollar deal. What if the training was performed privately, in a richly modeled simulation of the workers actual job? In a simulated environment, failure would result in dedicated instruction  
10 instead of embarrassment, injury, or monetary losses. Simulated environments provide a sense of liberation for exploration that does not exist in the real world. Knowing that the consequences of experimentation will unlikely be dire, learners are able to explore the "what if..." inherent in us all. In this way, the best way to prepare for high performance is to *simulate* actual performance. New media technologies  
15 utilizing multimedia provide the possibility to create such business simulation experiences.

- Even if companies didn't make the mistake of focusing on "what" learning vs. "how" learning, they still tend to have the overly narrow view of education/training as  
20 something that only occurs prior to workers being asked to actually perform their job. Learning is something that is constantly occurring, and doesn't cease once "real work" has begun. The closer new lessons occur in time with the application of those lessons, the greater the resultant learning. This fact helps to explain some of the reasoning behind the benefits of business simulation, described in the previous  
25 section. In those systems, all new lessons are taught in close relationship to their real world use; everything is in context and, most importantly, are presented at the appropriate time. But as the properly trained worker performs their job, the working environment changes. New demands occur, and new methods and rules are developed. As these events occur, there is a need for new support/training that, in  
30 most cases, must wait to be addressed until the next "pre-performance" training session.

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In these cases, the need (or demand) for additional training doesn't match the supply. This lag between a training need and the fulfilling lesson has a dramatic negative impact on productivity, accuracy, and customer satisfaction. Workers need to have the opportunity to learn *while* they are performing. Just as during pre-performance training, one powerful mechanism for identifying and correcting (simulated) performance problems is to have an expert available at all time to watch your actions and remediate when appropriate. This, obviously, is too costly and time intensive of an approach to be practical with actual experts. But what if workers had access to a support system that provided the majority of the benefits of a real expert, transparently integrated into their work environment? Such a system would provide advice at key moments in the work flow for problem resolution and/or process improvement, tools to ease task completion, reference material of best practice knowledge, and point of need training courses. With a support system that proactively assists the worker in performance of their job tasks at a higher level of competency, productivity and customer satisfaction (both internal and external) would soar.

The key to such a support system is that it is seamlessly integrated into the business system that the knowledge worker uses to execute their job tasks. Workers don't need to go "off-line" or seek out cryptic information buried within paper manuals and binders for guidance or to find the answer to queries. All the support components are made available through the same applications the worker's use, at the point in which they need them, tailored to the individual to show "how", not just "what". Learning would be occurring all the time, with little distinction between performing and improving performance.

Establishing that training should focus on performance (how), rather than facts (what), and extending the model of learning to include assistance while performing, rather than only before performance, still leaves us dangerously exposed in preparing to compete in the new, chaotic economy. As was mentioned in the

opening of this paper, the pace of change in business today is whiplash fast. Not only are new methods of doing business evolving every 18-24 months, new competitors emerge, dominate, and fade in time periods businesses used to take to perform demographic studies. Now more than ever, those who do not reinvent themselves on a regular basis will be fossilized by the pace of change.

Even the best pre-performance training and the most advanced performance support tools are destined to be outdated if there isn't a fresh supply of real-world requirements and lessons learned being fed back as inputs for the next go 'round.

10 Innovation is a key step in the Workforce Performance Cycle. This step requires business to employ Stephen Covey's famous habit of "sharpening the saw", or "take time to be fast".

There is an untold wealth of information buried within the heads of business users responsible for implementing the steps outlined in their pre-performance training and performance support tools. No other group within an organization can more accurately assess the effectiveness of current methods, or project needed changes that will have dramatic future impact. This step of reflecting on the current and past state of affairs, uncovering new approaches by identifying what is working and what is not, and adapting accordingly for the future is the last phase of the learning/performance cycle.

Innovation to fuel future training and performance support comes directly from the community most closely tied to task performance. Effective businesses need to develop and cultivate a mechanism for communication and collaboration among the experts in these communities to more efficiently benefit from their collective wisdom. In today's business, that which is evident to your business is evident to nearly all your competitors as well. The competitive advantage lies in uncovering that which is unexpected or not immediately apparent, adapting your business processes to exploit the discovery, and quickly, but effectively, educating your

workforce on the new policies and procedures, all before the competition catches on or the market changes again.

5 This innovation process is the critical final step in continuous education of the most effective and up-to-date policies, procedures, and information. Without formalized innovation, companies not only risk being a step behind the ever advancing competition, but compound the problem by continuing to train their personnel with outdated strategies and information. One way to formalize this vital step in the Workforce Performance Cycle is to construct Virtual Learning Communities, where  
10 many 'experts' can share experiences, submit ideas for improvements, play out "what-if" scenarios, and contribute on complex problems that may be insurmountable without significant collaboration with others. Such Learning Communities could nurture up-to-date discussion of what is actually happening within a business, eliminating the traditional information-passing lag that plagues  
15 many business as new data travels through corporate hierarchies. This increased nimbleness would help organizations quickly address new competitive trends and outdated strategies, identify potential solutions, and implement improved processes in the form of updated training and performance support reference materials.

20 Currently, a typical BusSim engagement takes between one and two years to complete and requires a variety of both functional and technical skills. Figure 3 depicts the timeline and relative resource requirements for each phase of development for a typical application development in accordance with a preferred embodiment. The chart clearly depicts the relationship between the large number of  
25 technical resources required for both the build and test phases of development. This is because the traditional development process used to build BusSim solutions reflects more of a "one off" philosophy, where development is done from scratch in a monolithic fashion, with little or no reuse from one application to the next. This lack of reuse makes this approach prohibitively expensive, as well as lengthy, for  
30 future BusSim projects.

The solution to this problem is to put tools in the hands of instructional designers that allows them to create their BusSim designs and implement them without the need for programmers to write code. And to put application architectures that integrate with the tools in the hands of developers, providing them with the ability to quickly deliver solutions for a number of different platforms. The reuse, then, comes in using the tools and architectures from one engagement to another. Both functional and technical resources carry with them the knowledge of how to use the technology, which also has an associated benefit of establishing a best-practice development methodology for BusSim engagements.

The tools and architectures described herein are part of a next-generation Business Simulation delivery framework that will reduce the total effort necessary to build solutions in accordance with a preferred embodiment. Figure 4 depicts the potential savings in both functional and technical tasks in accordance with a preferred embodiment.

### **Development Cycle Activities**

#### ***Design Phase***

In the Design Phase, instructional designers become oriented to the content area and begin to conceptualize an instructional approach. They familiarize themselves with the subject matter through reading materials and interviews with Subject Matter Experts (SMEs). They also identify learning objectives from key client contacts. Conceptual designs for student interactions and interface layouts also begin to emerge. After the conceptual designs have taken shape, Low-Fi user testing (a.k.a. Conference Room Piloting) is performed. Students interact with interface mock-ups while facilitators observe and record any issues. Finally, detailed designs are created that incorporate findings. These detailed designs are handed off to the development team for implementation.

The design phase has traditionally been fraught with several problems. Unlike a traditional business system, BusSim solutions are not rooted in tangible business

processes, so requirements are difficult to identify in a concrete way. This leaves instructional designers with a 'blue sky' design problem. With few business-driven constraints on the solution, shallow expertise in the content area, and limited technical skills, instructional designers have little help in beginning a design.

- 5 Typically, only experienced designers have been able to conjure interface, analysis, and feedback designs that meet the learning objectives yet remain technically feasible to implement. To compound the problem, BusSim solutions are very open ended in nature. The designer must anticipate a huge combination of student behavior to design feedback that is helpful and realistic.

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### ***Build Phase***

- During the build phase, the application development team uses the detailed designs to code the application. Coding tasks include the interfaces and widgets that the student interacts with. The interfaces can be made up of buttons, grids, check boxes,
- 15 or any other screen controls that allow the student to view and manipulate his deliverables. The developer must also code logic that analyzes the student's work and provides feedback interactions. These interactions may take the form of text and/or multimedia feedback from simulated team members, conversations with simulated team members, or direct manipulations of the student's work by
- 20 simulated team members. In parallel with these coding efforts, graphics, videos, and audio are being created for use in the application. Managing the development of these assets have their own complications.

- Risks in the build phase include misinterpretation of the designs. If the developer
- 25 does not accurately understand the designer's intentions, the application will not function as desired. Also, coding these applications requires very skilled developers because the logic that analyzes the student's work and composes feedback is very complex.

### *Test Phase*

The Test Phase, as the name implies, is for testing the application. Testing is performed to verify the application in three ways: first that the application functions properly (functional testing), second that the students understand the interface and can navigate effectively (usability testing), and third that the learning objectives are met (cognition testing). Functional testing of the application can be carried out by the development team or by a dedicated test team. If the application fails to function properly, it is debugged, fixed, recompiled and retested until its operation is satisfactory. Usability and cognition testing can only be carried out by test students who are unfamiliar with the application. If usability is unsatisfactory, parts of the interface and or feedback logic may need to be redesigned, recoded, and retested. If the learning objectives are not met, large parts of the application may need to be removed and completely redeveloped from a different perspective.

The test phase is typically where most of the difficulties in the BusSim development cycle are encountered. The process of discovering and fixing functional, usability, and cognition problems is a difficult process and not an exact science.

For functional testing, testers operate the application, either by following a test script or by acting spontaneously and documenting their actions as they go. When a problem or unexpected result is encountered, it too is documented. The application developer responsible for that part of the application then receives the documentation and attempts to duplicate the problem by repeating the tester's actions. When the problem is duplicated, the developer investigates further to find the cause and implement a fix. The developer once again repeats the tester's actions to verify that the fix solved the problem. Finally, all other test scripts must be rerun to verify that the fix did not have unintended consequences elsewhere in the application.

This process has inherent difficulty. If the tester is inaccurate in recording his actions, or the developer is inaccurate in repeating them, then the problem may never

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### *Execution Phase*

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One of the key values of on-line courses is that they can be taken at a time, location, and pace that is convenient for the individual student. However, because students are not centrally located, support is not always readily available. For this reason it is often desirable to have phone support for students.

Clients may also desire to track students' progress, or control their advancement through the course. Under this strategy, after a student completes a section of the course, he will transfer his progress data to a processing center either electronically or by physically mailing a disk. There it can be analyzed to verify that he completed all required work satisfactorily. One difficulty commonly associated with student tracking is isolating the student data for analysis. It can be unwieldy to transmit all the course data, so it is often imperative to isolate the minimum data required to perform the necessary analysis of the student's progress.

#### **A Delivery Framework for Business Simulation**

As discussed earlier, the traditional development process used to build BusSim solutions reflects more of a "one off" philosophy, where development is done from scratch in a monolithic fashion, with little or no reuse from one application to the next. A better approach would be to focus on reducing the total effort required for development through reuse, which, in turn would decrease cost and development time.

The first step in considering reuse as an option is the identification of common aspects of the different BusSim applications that can be generalized to be useful in future applications. In examination of the elements that make up these applications, three common aspects emerge as integral parts of each:

- Interface
- Analysis
- Interpretation

## **Interface**

Every BusSim application must have a mechanism for interaction with the student. The degree of complexity of each interface may vary, from the high interactivity of a high-fidelity real-time simulation task, to the less complex information delivery requirements of a business case background information task. Regardless of how sophisticated the User Interface (UI), it is a vital piece of making the underlying simulation and feedback logic useful to the end user.

## **Analysis**

- 10 Every BusSim application does analysis on the data that defines the current state of the simulation many times throughout the execution of the application. This analysis is done either to determine what is happening in the simulation, or to perform additional calculations on the data which are then fed back into the simulation. For example, the analysis may be the recognition of any actions the student has taken on artifacts within the simulated environment (notebooks, number values, interviews conducted, etc.), or it may be the calculation of an ROI based on numbers the student has supplied.

## **Interpretation**

- 20 Substantive, useful feedback is a critical piece of any BusSim application. It is the main mechanism to communicate if actions taken by the student are helping or hurting them meet their performance objectives. The interpretation piece of the set of proposed commonalties takes the results of any analysis performed and makes sense of it. It takes the non-biased view of the world that the Analysis portion delivers (i.e., "Demand is up 3%") and places some evaluative context around it (i.e., "Demand is below the expected 7%; you're in trouble!", or "Demand has exceeded projections of 1.5%; Great job!"). Figure 5 illustrates commonalties in accordance with a preferred embodiment.

## **30 Common Features of Business Simulation Applications**

There are several approaches to capturing commonalities for reuse. Two of the more common approaches are framework-based and component-based. To help illustrate the differences between the two approaches, we will draw an analogy between building an application and building a house. One can construct a house from scratch, using the raw materials, 2x4s, nails, paint, concrete, etc. One can also construct an application from scratch, using the raw materials of new designs and new code. The effort involved in both undertakings can be reduced through framework-based and/or component-based reuse.

#### 10 ***Framework-Based Reuse***

Within the paradigm of framework-based reuse, a generic framework or architecture is constructed that contains commonalities. In the house analogy, one could purchase a prefabricated house framework consisting of floors, outside walls, bearing walls and a roof. The house can be customized by adding partition walls, wall-paper, 15  
woodwork, carpeting etc. Similarly, prefabricated application frameworks are available that contain baseline application structure and functionality. Individual applications are completed by adding specific functionality and customizing the look-and-feel. An example of a commonly used application framework is Microsoft Foundation Classes. It is a framework for developing Windows applications using 20  
C++. MFC supplies the base functionality of a windowing application and the developer completes the application by adding functionality within the framework. Framework-based reuse is best suited for capturing *template-like* features, for example user interface management, procedural object behaviors, and any other features that may require specialization.

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Some benefits of using a framework include:

- **Extensive functionality can be incorporated into a framework.** In the house analogy, if I know I am going to build a whole neighborhood of three bedroom ranches, I can build the plumbing, wiring, and partition walls right into the 30  
framework, reducing the incremental effort required for each house. If I know I am

going to build a large number of very similar applications, they will have more commonalties that can be included in the framework rather than built individually.

- **Applications can override the framework-supplied functionality wherever appropriate.** If a house framework came with pre-painted walls, the builder could just paint over them with preferred colors. Similarly, the object oriented principle of inheritance allows an application developer to override the behavior of the framework.

### ***Component-Based Reuse***

- 10 In the paradigm of component-based reuse, key functionality is encapsulated in a component. The component can then be reused in multiple applications. In the house analogy, components correspond to appliances such as dishwashers, refrigerators, microwaves, etc.
- Similarly, many application components with pre-packaged functionality are available from a variety of vendors. An example of a popular component is a Data Grid. It is a component that can be integrated into an application to deliver the capability of viewing columnar data in a spreadsheet-like grid. Component-based reuse is best suited for capturing *black-box-like* features, for example text processing, data manipulation, or any other features that do not require specialization.
- 20

Some benefits of using components include:

- **Several applications on the same computer can share a single component.** This is not such a good fit with the analogy, but imagine if all the houses in a neighborhood could share the same dishwasher simultaneously. Each home would have to supply its own dishes, detergent, and water, but they could all wash dishes in parallel. In the application component world, this type of sharing is easily accomplished and results in reduced disk and memory requirements.
  - **Components tend to be less platform and tool dependent.** A microwave can be used in virtually any house, whether it's framework is steel or wood, and regardless of whether it was customized for building mansions or shacks. You can
- 30

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put a high-end microwave in a low-end house and vice-versa. You can even have multiple different microwaves in your house. Component technologies such as CORBA, COM, and Java Beans make this kind of flexibility commonplace in application development.

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*The Solution: A Combined Approach*

Often, the best answer to achieving reuse is through a combination of framework-based and component-based techniques. A framework-based approach for building BusSim applications is appropriate for developing the user interface, handling user and system events, starting and stopping the application, and other application-specific and delivery platform-specific functions. A component-based approach is appropriate for black-box functionality. That is, functionality that can be used as-is with no specialization required.

15 In creating architectures to support BusSim application development, it is imperative that any assets remain as flexible and extensible as possible or reusability may be diminished. Therefore, we chose to implement the unique aspects of BusSim applications using a component approach rather than a framework approach. This decision is further supported by the following observations.

20 ▪ **An application can only be based on one framework.** Using the house analogy, if you like the first floor of one framework and the second floor of another, it is difficult or impossible to integrate the features of the two. Or, it is so costly as to erase the benefit of using a framework in the first place. Likewise with application frameworks. You can only use one framework when building an application. You can't mix and match features from multiple frameworks, so any framework that we developed would have to compete against existing and future frameworks. With components, however, you can mix and match from multiple vendors.

25 ▪ **Components are less platform and development tool dependent, leaving more options open for development teams.** An appliance like a dishwasher is not restricted for use in a particular type of house. Similarly, component technologies

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exist that are independent of platform and development tool. For example ActiveX can be used in almost every development environment for Windows and Java Beans components can be used on a wide variety of platforms.

- **Frameworks become obsolete more quickly.** Rapid emergence and evolution of technology has introduced a wealth of new feature requirements into application development. Frameworks that do not include the most current features become obsolete quickly. Components typically address a more focused feature set and are not as impacted by technology advances outside their core functionality areas.

- 10 Based on these observations, we believe a combined framework/component approach is optimal for achieving reuse. Figure 6 illustrates a development architecture approach in accordance with a preferred embodiment.

#### **Delivery Framework for Business Simulation**

- 15 This diagram illustrates an ideal solution where components are combined with an Application Framework and an Application Architecture to achieve maximum reuse and minimum custom development effort. The Application Architecture is added to provide communication support between the application interface and the components, and between the components. This solution has the following features:
- 20 ▪ The components (identified by the icons) encapsulate key BusSim functionality.
  - The Application Architecture provides the glue that allows application-to-component and component-to-component communication.
  - The Application Framework provides structure and base functionality that can be customized for different interaction styles.
  - 25 ▪ Only the application interface must be custom developed.

The next section discusses each of these components in further detail.

#### **The Business Simulation Toolset**

- We have clearly defined why a combined component/framework approach is the best solution for delivering high-quality BusSim solutions at a lower cost. Given that there are a number of third party frameworks already on the market that provide

delivery capability for a wide variety of platforms, the TEL project is focused on defining and developing a set of components that provide unique services for the development and delivery of BusSim solutions. These components along with a set of design and test workbenches are the tools used by instructional designers to support activities in the four phases of BusSim development. We call this suite of tools the Business Simulation Toolset. Following is a description of each of the components and workbenches of the toolset.

### *Components*

- 10 A **Component** can be thought of as a black box that encapsulates the behavior and data necessary to support a related set of services. It exposes these services to the outside world through published interfaces. The published interface of a component allows you to understand what it does through the services it offers, but not how it does it. The complexity of its implementation is hidden from the user. The following are the key components of the BusSim Toolset.
- 15
    - Domain Component - provides services for modeling the state of a simulation
    - Profiling Component - provides services for rule-based evaluating the state of a simulation
    - Transformation Component - provides services for manipulating the state of a simulation
    - 20 ▪ Remediation Component - provides services for the rule-based delivering of feedback to the student

### **Domain Component**

- 25 The Domain Model component is the central component of the suite that facilitates communication of context data across the application and the other components. It is a modeling tool that can use industry-standard database such as Informix, Oracle, or Sybase to store its data.

A **domain model** is a representation of the objects in a simulation. The objects are such pseudo tangible things as a lever the student can pull, a form or notepad the student fills out, a character the student interacts with in a simulated meeting, etc.

- Vehicles, operators and incidents in an insurance domain

- An entity can also contain other entities. For example, a personal bank account entity might contain an entity that represents a savings account. Every entity has a set of *properties* where each property in some way describes the entity. The set of properties owned by an entity, in essence, define the entity. Some example properties include:

- ### Example Domain Model

At runtime, an application's domain model is instantiated so that every entity and property is given a particular value that makes it unique. The result of a domain model instantiation is called the *domain*. The values of a domain's entities and

properties can change throughout the course of the simulation based on student actions and updates from other components. Figure 8 illustrates an instantiated domain model in accordance with a preferred embodiment.

## 5 Example Domain

Creating a domain model in data rather than in code facilitates reuse of the components in multiple applications in multiple domains without code changes. For example, a typical application in the Financial Services domain would have to define classes in code such as 'Customer', 'Account', etc. An Insurance Domain application might have classes such as 'Customer', 'Incident', 'Prior Policy', etc. To be able to perform analysis on any of these classes, the analysis logic must be coded to recognize the classes. This requires all logic to be custom-coded for every application; an effort-intensive undertaking that demands a high degree of technical skill.

By modeling the domain in data using generic objects, we can build standard generic analysis capability that can be applied to the domain. This allows implementation of analysis logic with much less effort by people with a low degree of technical skill. Functional experts can create the objects of the domain and apply various types of analysis from a pallet. All of this is accomplished in a visual development environment that supports the designer with visual feedback and only allows valid designs to be created.

## Profiling Component

In the simplest terms, the purpose of the Profiling Component is to analyze the current state of a domain and identify specific things that are true about that domain. This information is then passed to the Remediation Component which provides feedback to the student. The Profiling Component analyzes the domain by asking questions about the domain's state, akin to an investigator asking questions about a case. The questions that the Profiler asks are called profiles. For example, suppose there is a task about building a campfire and the student has just thrown a match on a

pile of wood, but the fire didn't start. In order to give useful feedback to the student, a tutor would need to know things like: was the match lit?, was the wood wet?, was there kindling in the pile?, etc. These questions would be among the profiles that the Profiling Component would use to analyze the domain. The results of the analysis  
 5 would then be passed off to the Remediation Component which would use this information to provide specific feedback to the student.

Specifically, a *profile* is a set of criteria that is matched against the domain. The purpose of a profile is to check whether the criteria defined by the profile is met in  
 10 the domain. Using a visual editing tool, instructional designers create profiles to identify those things that are important to know about the domain for a given task. During execution of a BusSim application at the point that feedback is requested either by the student or pro-actively by the application, the set of profiles associated with the current task are evaluated to determine which ones are true. Example  
 15 profiles include:

- Good productions strategy but wrong Break-Even Formula
- Good driving record and low claims history
- Correct Cash Flow Analysis but poor Return on Investment (ROI)

20 A profile is composed of two types of structures: characteristics and collective characteristics. A *characteristic* is a conditional (the *if* half of a rule) that identifies a subset of the domain that is important for determining what feedback to deliver to the student. Example characteristics include:

- Wrong debit account in transaction 1
- 25 ▪ Perfect cost classification
- At Least 1 DUI in the last 3 years
- More than \$4000 in claims in the last 2 years
- More than two at-fault accidents in 5 years

30 A characteristic's conditional uses one or more atomics as the operands to identify the subset of the domain that defines the characteristic. An *atomic* only makes

reference to a single property of a single entity in the domain; thus the term atomic.

Example atomics include:

- The number of DUI's  $\geq 1$
- $ROI > 10\%$
- 5   ▪ Income between \$75,000 and \$110,000

A *collective characteristic* is a conditional that uses multiple characteristics and/or other collective characteristics as its operands. Collective characteristics allow instructional designers to build richer expressions (i.e., ask more complex

10   questions). Example collective characteristics include:

- Bad Household driving record
- Good Credit Rating
- Marginal Credit Rating
- Problems with Cash for Expense transactions
- 15   ▪ Problems with Sources and uses of cash

Once created, designers are able to reuse these elements within multiple expressions, which significantly eases the burden of creating additional profiles. When building a profile from its elements, atomics can be used by multiple characteristics, characteristics can be used by multiple collective characteristics and profiles, and collective characteristics can be used by multiple collective characteristics and profiles.

Figure 9 illustrates an insurance underwriting profile in accordance with a preferred embodiment.

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### Example Profile for Insurance Underwriting

#### Transformation Component

30   Whereas the Profiling Component asks questions about the domain, the Transformation Component performs calculations on the domain and feeds the

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- results back into the domain for further analysis by the Profiling Component. This facilitates the modeling of complex business systems that would otherwise be very difficult to implement as part of the application. Within the Analysis phase of the Interface/Analysis/Interpretation execution flow, the Transformation Component
- 5 actually acts on the domain before the Profiling Component does its analysis. The Transformation Component acts as a shell that wraps one or more data modeling components for the purpose of integrating these components into a BusSim application. The Transformation Component facilitates the transfer of specific data from the domain to the data modeling component (inputs) for
- 10 calculations to be performed on the data, as well as the transfer of the results of the calculations from the data modeling component back to the domain (outputs). Figure 10 illustrates a transformation component in accordance with a preferred embodiment.
- 15 The data modeling components could be third party modeling environments such as spreadsheet-based modeling (e.g., Excel, Formula1) or discrete time-based simulation modeling (e.g., PowerSim, VenSim). The components could also be custom built in C++, VB, Access, or any tool that is ODBC compliant to provide unique modeling environments. Using the Transformation Component to wrap a
- 20 third party spreadsheet component provides an easy way of integrating into an application spreadsheet-based data analysis, created by such tools as Excel. The Transformation Component provides a shell for the spreadsheet so that it can look into the domain, pull out values needed as inputs, performs its calculations, and post outputs back to the domain.
- 25 For example, if the financial statements of a company are stored in the domain, the domain would hold the baseline data like how much cash the company has, what its assets and liabilities are, etc. The Transformation Component would be able to look at the data and calculate additional values like cash flow ratios, ROI or NPV of investments, or any other calculations to quantitatively analyze the financial health
- 30 of the company. Depending on their complexity, these calculations could be

performed by pre-existing spreadsheets that a client has already spent considerable time developing.

### **Remediation Component**

- 5 The Remediation Component is an expert system that facilitates integration of intelligent feedback into BusSim applications. It has the following features:
- Ability to compose high quality text feedback.
  - Ability to compose multimedia feedback that includes video and/or audio.
  - Ability to include reference material in feedback such as Authorware pages or
- 10 Web Pages.
- Ability to actively manipulate the users deliverables to highlight or even fix users' errors.
  - A proven remediation theory embedded in its feedback composition algorithm.
  - Allows integration of digital assets into the Remediation of a training or IPS
- 15 application.

The Remediation model consists of three primary objects:

- Concepts
  - Coach Topics
- 20 ▪ Coach Items

*Concepts* are objects that represent real-world concepts that the user will be faced with in the interface. Concepts can be broken into sub-concepts, creating a hierarchical tree of concepts. This tree can be arbitrarily deep and wide to support

25 rich concept modeling. Concepts can also own an arbitrary number of Coach Topics.

*Coach Topics* are objects that represent a discussion topic that may be appropriate for a concept. Coach Topics can own an arbitrary number of Coach Items.

*Coach Items* are items of feedback that may include text, audio, video, URL's, or

30 updates to the Domain Model. Coach Items are owned by Coach Topics and are assembled by the Remediation Component algorithm.

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Details of the Remediation Component algorithm for feedback is discussed in **The Intelligent Coaching Agent Tool** whitepaper and can be found on the Knowledge Exchange at the Technology Enabled Learning ETA Home Page.

## 5 **Workbenches**

The BusSim Toolset also includes a set of workbenches that are used by instructional designers to design and build BusSim applications. A *workbench* is a tool that facilitates visual editing or testing of the data that the BusSim Components use for determining an application's run-time behavior. The BusSim Toolset

10 includes the following workbenches:

### **Knowledge Workbench**

The Knowledge Workbench is a tool for the creation of domain, analysis and feedback data that is used by the BusSim Components. It has the following features:

- Allows the designer to 'paint' knowledge in a drag-and-drop interface.
- 15 ▪ Knowledge is represented visually for easy communication among designers.
- The interface is intelligent, allowing designers to only paint valid interactions.
- Designer's Task creations are stored in a central repository.
- The workbench supports check-in / check-out for exclusive editing of a task.
- Supports LAN-based or untethered editing.
- 20 ▪ Automatically generates documentation of the designs.
- Generates the data files that drive the behavior of the components.

### **Simulated Student Test Workbench**

The Simulated Student Test Workbench is a tool for the creation of data that  
25 simulates student's actions for testing BusSim Component behaviors. It has the following features:

- The Test Bench generates a simulated application interface based on the Domain Model.
- The designer manipulates the objects in the Domain Model to simulate student  
30 activity.

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The Regression Test Workbench is a tool for replaying and testing of student sessions to aid debugging. It has the following features:

- 15

### *Design Phase*

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As the test student interacts with screen mock-ups, a facilitator can mimic his actions in the interface simulator and tell the student what the actual feedback will be. This results in much more rigorous testing prior to application construction. A big payoff is realized downstream in the form of reduced redesign after usability and cognition

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testing.

Throughout all these steps in the initial design, the workbench supports the design process by allowing the designer great flexibility within the framework of a proven methodology. This allows experienced users to design rich, realistic interactions, and inexperienced users to become competent in a shorter time by learning from the best practices embedded in the workbench. This greatly diminishes the 'blue sky' design problem. Also, since the designs can be tested prior to application construction, there is reduced rework after testing. Lastly, the visual knowledge representation enhances communication within the design team and greatly streamlines the QA process.

### ***Build Phase***

It is very clear how the tools support the Build Phase. The designs that the designer painted in the Knowledge Workbench drive the components at runtime. The application developer no longer has to write code that analyzes the student's work and provides feedback. The developer only has to build the interface and logic to report any student actions to the domain model. The components do the rest. What used to be the most difficult part of the build phase has been eliminated!

There is no chance for a developer to misinterpret the feedback designs because she never has to interpret them. In fact, the developer doesn't even have to know anything about the feedback behavior as long as she is familiar with the domain model. This also means the skill level required to develop the application can be greatly reduced. It's not hard to teach someone how to paint a screen in Visual Basic or Delphi and call API functions to notify the Domain Model of student actions.

In addition to the economics gained by the components, it is possible to use templates to further streamline design and development of commonly used interactions. We have created templates for several common interactions. For example, Journalizing of Transactions is an interaction that has appeared in several applications. We have built application and Knowledge Workbench templates for

Journalization. All one must do to create a new Journalize task is to add graphics for new Transactions and fill in new data into placeholders in the Knowledge Workbench.

## 5 *Test Phase*

10 The toolset greatly reduces effort during functionality testing. The key driver of the effort reduction is that the components can automatically track the actions of the tester without the need to add code support in the application. Whenever the tester takes an action in the interface, it is reported to the domain model. From there it can be tracked in a database. Testers no longer need to write down their actions for use in debugging; they are automatically written to disk. There is also a feature for attaching comments to a tester's actions. When unexpected behavior is encountered, the tester can hit a control key sequence that pops up a dialog to record a description of the errant behavior.

15 Of far greater impact is the ability to replay the tester's actions automatically through the Regression Test Workbench. The designer does not need to spend hours trying to duplicate the error. She simply loads the tester's session into the Regression Test Workbench and replays it. In seconds the error is replicated and can be located and fixed using a variety of debugging utilities. After changes have been made, one more pass through the Regression Test Workbench verifies the fix.

25 The major difficulties of usability and cognition testing are also addressed by the toolset. First, since student tracking is no longer a manual activity, the precision of functional testing can also be applied to usability and cognition testing. Second, because of the increased rigor in the Conference Room Pilot, the risk of significant rework is greatly reduced.

## *Execution Phase*

30 During the Execution Phase, the components are deployed to the student's platform. They provide simulated team member and feedback functionality with sub-second

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response time and error-free operation. If the client desires it, student tracking mechanisms can be deployed at runtime for evaluation and administration of students. This also enables the isolation of any defects that may have made it to production.

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### **Scenarios for Using the Business Simulation Toolset**

A good way to gain a better appreciation for how the BusSim Toolset can vastly improve the BusSim development effort is to walk through scenarios of how the tools would be used throughout the development lifecycle of a particular task in a BusSim application. For this purpose, we'll assume that the goal of the student in a specific task is to journalize invoice transactions, and that this task is within the broader context of learning the fundamentals of financial accounting. A cursory description of the task from the student's perspective will help set the context for the scenarios. Following the description are five scenarios which describe various activities in the development of this task. The figure below shows a screen shot of the task interface.

Figure 11 illustrates the use of a toolbar to navigate and access application level features in accordance with a preferred embodiment. A student uses a toolbar to navigate and also to access some of the application-level features of the application. The toolbar is the inverted L-shaped object across the top and left of the interface. The top section of the toolbar allows the user to navigate to tasks within the current activity. The left section of the toolbar allows the student to access other features of the application, including feedback. The student can have his deliverables analyzed and receive feedback by clicking on the Team button.

In this task, the student must journalize twenty-two invoices and other source documents to record the flow of budget dollars between internal accounts. (Note: "Journalizing", or "Journalization", is the process of recording journal entries in a general ledger from invoices or other source documents during an accounting period. The process entails creating debit and balancing credit entries for each document.

At the completion of this process, the general ledger records are used to create a trial balance and subsequent financial reports.)

10 In accordance with a preferred embodiment, an Intelligent Coaching Agent Tool (ICAT) was developed to standardize and simplify the creation and delivery of feedback in a highly complex and open-ended environment. Feedback from a coach or tutor is instrumental in guiding the learner through an application. Moreover, by diagnosing trouble areas and recommending specific actions based on predicted student understanding of the domain student comprehension of key concepts is increased. By writing rules and feedback that correspond to a proven feedback strategy, consistent feedback is delivered throughout the application, regardless of the interaction type or of the specific designer/developer creating the feedback. The ICAT is packaged with a user-friendly workbench, so that it may be reused to increase productivity on projects requiring a similar rule-based data engine and repository.

#### **Definition of ICAT In Accordance with a Preferred Embodiment**

20 The Intelligent Coaching Agent Tool (ICAT) is a suite of tools--a database and a Dynamic Link Library (DLL) run-time engine — used by designers to create and execute just-in-time feedback of Goal Based training. Designers write feedback and rules in the development tools. Once the feedback is set, the run-time engine monitors user actions, fires rules and composes feedback which describes the business deliverable.

#### **25 I. The ICAT Remediation Model**

The remediation model used within ICAT dynamically composes the most appropriate feedback to deliver to a student based on student's previous responses. The ICAT model is based on a theory of feedback which has been proven effective by pilot results and informal interviews. The model is embodied in the object model and algorithms of the ICAT. Because the model is built into the tools, all feedback

created with the tool will conform to the model.

## **II. The Role of ICAT in Student Training**

The ICAT plays two roles in student training. First, the ICAT is a teaching system,  
5 helping students to fully comprehend and apply information. Second, ICAT is a  
gatekeeper, ensuring that each student has mastered the material before moving on to  
additional information.

## **III. The Functional Definition of the ICAT**

10 The ICAT is a self contained module, separate from the application. Separating the  
ICAT from the application allows other projects to use the ICAT and allows  
designers to test feedback before the application is complete. The ICAT Module is  
built on six processes which allow a student to interact effectively with the interface  
to compose and deliver the appropriate feedback for a student's mistakes.

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## **IV. The ICAT Development Methodology for Creating Feedback**

The ICAT development methodology is a seven step methodology for creating  
feedback. The methodology contains specific steps, general guidelines and lessons  
learned from the field. Using the methodology increases the effectiveness of the  
20 feedback to meet the educational requirements of the course.

## **V. Components**

The processes each contain a knowledge model and some contain algorithms. Each  
process has specific knowledge architected into its design to enhance remediation  
25 and teaching.

## **VI. Testing Utilities, Reports and Methodology**

There is a suite of testing tools for the ICAT. These tools allow designers and  
developers test all of their feedback and rules. In addition, the utilities let designers  
30 capture real time activities of students as they go through the course.

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The tools and run-time engine in accordance with a preferred embodiment include expert knowledge of remediation. These objects include logic that analyzes a

10 Any project which is creating a Goal-Based Scenario (GBS) business simulation or an Integrated Performance Support (IPS) system to help users understand and create business deliverables can profit from technology in accordance with a preferred embodiment. A GBS allows students to learn in a comprehensive simulated environment. Students work in a simulated environment to accomplish real world tasks, and when they make mistakes, remediation is provided to help identify and correct the mistakes. The hands-on experience of the simulated environment and the timely remediation account for the high retention rate from subjects presented utilizing a system in accordance with a preferred embodiment. A system in accordance with a preferred embodiment can be used in conjunction with an IPS to help users develop deliverables. If a customer service representative (CSR) is completing a form while conducting a phone conversation, the ICAT can be used to observe how the task is completed to provide a live analysis of mistakes.

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When the architecture is installed in accordance with a preferred embodiment, the development directory has an \_Arch, \_Tools, \_Utilities, Documentation, QED, and XDefault development directory. Each folder has its own directory structure that is inter-linked with the other directories. This structure must be maintained to assure consistency and compatibility between projects to clarify project differences, and architecture updates.

The \_Arch directory stores many of the most common parts of the system architecture. These files generally do not change and can be reused in any area of the project. If there is common visual basic code for applications that will continuously be used in other applications, the files will be housed in a folder in this directory.

The sub-directories in the \_Arch directory are broken into certain objects of the main project. Object in this case refers to parts of a project that are commonly referred to within the project. For example, modules and classes are defined here, and the directory is analogous to a library of functions, APIs, etc... that do not change. For example the IcaObj directory stores code for the Intelligent Coaching Agent (ICA). The InBoxObj directory stores code for the InBox part of the project and so on. The file structure uses some primary object references as file directories. For example, the IcaObj directory is a component that contains primary objects for the ICA such as functional forms, modules and classes.

The **BrowserObj** directory contains modules, classes and forms related to the browser functionality in the architecture.

The **HTMLGlossary** directory contains code that is used for the HTML reference and glossary component of the architecture.

The **IcaObj** directory contains ICA functional code to be used in an application. This code is instantiated and enhanced in accordance with a preferred embodiment.

5 The **InBoxObj** directory contains code pertaining to the inbox functionality used within the architecture. Specifically, there are two major components in this architecture directory. There is a new .ocx control that was created to provide functionality for an inbox in the application. There is also code that provides support for a legacy inbox application. The **PracticeObj** directory contains code for the topics component of the architecture. The topics component can be implemented  
10 with the HTMLGlossary component as well.

The **QmediaObj** directory contains the components that are media related. An example is the QVIDctrl.cls. The QVIDctrl is the code that creates the links between QVID files in an application and the system in accordance with a preferred  
15 embodiment.

The **SimObj** directory contains the Simulation Engine, a component of the application that notifies the tutor of inputs and outputs using a spreadsheet to facilitate communication.  
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The **StaticObj** directory holds any component that the application will use statically from the rest of the application. For example, the login form is kept in this folder and is used as a static object in accordance with a preferred embodiment.

25 The **SysDynObj** directory contains the code that allows the Systems Dynamics Engine (Powersim) to pass values to the Simulation Engine and return the values to the tutor.

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The **VBObj** directory contains common Visual Basic objects used in applications. For example the NowWhat, Visual Basic Reference forms, and specific message box components are stored in this folder.

- 5 The **\_Tools** directory contains two main directories. They represent the two most used tools in accordance with a preferred embodiment. The two directories provide the code for the tools themselves. The reason for providing the code for these tools is to allow a developer to enhance certain parts of the tools to extend their ability. This is important for the current project development and also for the growth of the
- 10 tools.

- The **Icautils** directory contains a **data**, **database**, **default**, **graphics**, **icadoc**, and **testdata** directory. The purpose of all of these directories is to provide a secondary working directory for a developer to keep their testing environment of enhanced
- 15 Icautils applications separate from the project application. It is built as a testbed for the tool only. No application specific work should be done here. The purpose of each of these directories will be explained in more depth in the project directory section. The TestData folder is unique to the **\_Tools/ICAUtils** directory. It contains test data for the regression bench among others components in ICAUtils.

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### Utilities

- The Utilities directory holds the available utilities that a Business Simulation project requires for optimal results. This is a repository for code and executable utilities that developers and designers may utilize and enhance in accordance with a preferred
- 25 embodiment. Most of the utilities are small applications or tools that can be used in the production of simulations which comprise an executable and code to go with it for any enhancements or changes to the utility. If new utilities are created on a project or existing utilities are enhanced, it is important to notify the managers or developers in charge of keeping track of the Business Simulation assets. Any

enhancements, changes or additions to the Business Simulation technology assets are important for future and existing projects.

### **Documentation**

5 A Documentation directory is used to store pertinent documentation. The documentation directory is structured as follows. Most of the directories are labeled after the specific information held within them. The following is a list of all the documentation directories and a description of what is contain in each.

10 **Ref Website** - This directory contains The Business Simulation Reference website, which is a general reference for many things. If the website has not been set up for users on a LAN or website, all you need to do is go into the root directory of website and double click on index.htm. This is the main page for the site.

15 **Components** - This directory contains any documentation on classes and modules that are used in the architecture. For example there are documents here on the ICAMeeting class, the Inbox class etc.

20 **Database** - This directory contains any documents describing the databases that are included and used in the Architecture. For example the ICAObj overview doc contains a description of the model and each element in the database.

**HTML Component** - This directory contains relevant documentation about the HTML part of the architecture.

25 **Process Models** - This directory should contain the documents that describe the process of the application or related information.

30 **ReferenceApp** - This directory contains documents with descriptions and views of the reference app. (QED) for explanation and documentation. Testing conditions are stored in the Testing directory.

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5    **UserGuides-** This directory has 6 sub-directories. Each one of these sub-directories contains user guides for a given tool or component in accordance with a preferred embodiment which include user guides for the architecture, the Tutor Suite, ICA Utilities, the simulation Engine and the System Dynamics Engine. There is also a directory for other documentation that contains user guides for any other tools or  
10    code like third party controls etc.

## Project Directory

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The SrcVB directory stores all of the directories previously described. The reason for duplicating the data and database directories is to assure that a developer does not interfere with the designer's files. The developer tends to not do as much design work and can easily corrupt files. This duplication of directories provides a safer environment for the developer to test in. As was mentioned above, the developer tends to have a lot more to do with the application build than the design so there needs to be more content in the SrcVB directory. The SrcVB directory also contains an .exe and .vbp file which are created in a developers visual basic application.

10 The following are directories found in the SrcVB directory that are not found in the Design directory followed by a short definition:

The **\_CustomArch** directory contains any application specific architecture. Look in the QED folder for an example.

15

The **\_CustomDistribution** directory contains any files that need to be distributed with the application.

20 The **Default** directory contains any backup files that might need to be copied and reused later. Some files occasionally are corrupted and need to be replaced.

The **Fonts** directory contains application specific font libraries.

25 The **Graphics** directory contains any relevant graphics for the application.

The **Help** directory contains all files for a help reference layer in the application. This can be implemented in many ways but most commonly in an HTML form.

30 The **Saved** directory is for saved information that is produced by the application. This can be used for saving student information or saving temporary information for the application steps.

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The **StudentData** directory is for storing any relevant student data, lists of students, their personal information or any relevant student data that needs to be saved.

5    **XDefault Development:**

The XDefault Development environment is used to provide a shell for any new project. A developer would rename this directory as an acronym of the project.

QED is the default for the installation sample application. The XDefault development directory is a shell and serves as a building block for a startup project.

- 10    A good idea is to use the QED sample application and build the XDefault Development project with the sample code in QED.

**Shared Development**

- 15    The last directory to be mentioned is the shared development directory which is placed on a LAN or central network area and is shared by all designers and developers of a project to assure that files in the project are up to date, managed properly and appropriately synchronized. There are many databases and files that will be shared in accordance with a preferred embodiment. These files need to be shared and have a location that someone can edit without having to worry about
- 20    merging files later. A source control program is used to restrict access to a file to one application at a time.

**The ICAT Model of Remediation**

- The ICAT has a model of remediation architected into the system in accordance with a preferred embodiment. Feedback should help students complete tasks and
- 25    learn the underlying concepts. To achieve this goal, the ICAT reviews student's work with the following objectives in mind.

**Identify student misconceptions**

- Identifying that a student does not understand a topic and then clearly explaining it
- 30    is the goal of human and computer tutors alike. Human tutors, however, have many

- more clues--including facial expressions and body language--to help them identify student misconceptions. The computer tutor is much more limited and can only view the outputs--such as documents and reports--the student produces. If a computer tutor is looking for a misunderstanding about debits and credits, the
- 5 computer analyzes all the mistakes a student made concerning debits and credits and tries to identify what misunderstanding would account for this pattern of mistakes.

#### **Identify what students should fix**

- If the coach cannot diagnose a student's misconception, or cannot do it with 100% accuracy, the coach must at least tell the student what he did wrong so that he can correct it. If at all possible, the coach should identify groups or types of problems the student is making so that the student can generalize the solution and answer.
- 10

#### **Prompt students to reflect on mistakes**

- 15 When identifying problems, the tutor needs to prompt the student to reflect on a problem and start to point the student towards the answer. The tutor should not tell the student the answer, but instead should attempt to provide an appropriate answer or give the student a question to think about.

#### **20 Reinforce correct concepts and ideas**

- Once a student has gotten the correct answer, it is important to reinforce the learning. Students may feel uncertain about their understanding even after he has gotten the answer correct. To reinforce the student's understanding of the concept and provide a confidence boost, the tutor should walk the student through the answer so that it is completely understood. These goals are not just the goals of a
- 25 computer tutor, but they are the goals of a human tutor as well. All tutors must look at a student's work to help identify and correct errors as well as learn the material. One of the most difficult tasks facing a tutor is the difficult task of balancing the appropriate amount of assistance provided the student to complete the task with the
- 30 requirement to help the student learn the material.

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## Model of Feedback

A preferred embodiment utilizes feedback to address the balancing task. The theory is centered on the idea of severity. Severe errors require severe feedback while mild errors require mild feedback. If a student writes a paper on the wrong subject, a human tutor will spend little time reviewing the paper, but instead, identify it as a serious mistake and ask the student to rewrite the paper. If the student simply misses one paragraph of the argument, then the tutor will focus the student on that paragraph. Finally, if the paper is correct except for a couple of spelling mistakes, the tutor will point out the specific mistakes and ask the student to correct them. The point is that because a tutor and a student do not want to waste each others' time, they will match the severity of the error with the severity of the feedback.

In the ICAT model of feedback, there are four levels of severity of error and four corresponding levels of feedback. The tutor goes through the student's work, identifies the severity of the error and then provides the corresponding level of feedback.

Educational Categories of Feedback			
ERROR		FEEDBACK	
Error Type	Description	Feedback Type	Description
1. None	No errors exist. The student's work is perfect.	1. Praise	Confirmation that the student completed the task correctly.  Example: Great. You have journalized all accounts correctly. I am happy to see you recognized we are paying for most of our bills "on account".

2. Syntactic	There may be spelling mistakes or other syntactic errors. As a designer, you should be confident that the student will have mastered the material at this point.	2. Polish	<p>Tells the student the specific actions he did incorrectly, and possibly correct them for him.</p> <p>Example:</p> <p>There are one or two errors in your work. It looks like you misclassified the purchase of the fax as a cash purchase when it is really a purchase on account.</p>
3. Local	<p>A paragraph of a paper is missing or the student has made a number of mistakes all in one area.</p> <p>The student clearly does not understand this area.</p>	3. Focus	<p>Focus the student on this area of his work. Point out that he does not understand at least one major concept.</p> <p>Example:</p> <p>Looking over your work, I see that you do not understand the concept of "on account". Why don't you review that concept and review your work for errors.</p>
4. Global	The student has written on the wrong subject or there are mistakes all over the student's work	4. Redirect	<p>Restate the goal of the activity and tell the student to review main concepts and retry the activity.</p> <p>Example:</p> <p>There are lots of mistakes</p>

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	which indicates he does not understand most of the concepts in the activity.		throughout your work. You need to think about what type of transaction each source document represents before journalizing it.
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Returning to the analogy of helping someone write a paper, if the student writes on the wrong subject, this as a global error requiring redirect feedback. If the student returns with the paper rewritten, but with many errors in one area of the paper, focus feedback is needed. With all of those errors fixed and only spelling mistakes-- syntactic mistakes--polish feedback is needed. When all syntactic mistakes were corrected, the tutor would return praise and restate why the student had written the correct paper.

- 10 Focusing on the educational components of completing a task is not enough. As any teacher knows, student will often try and cheat their way through a task. Students may do no work and hope the teacher does not notice or the student may only do minor changes in hope of a hint or part of the answer. To accommodate these administrative functions, there are three additional administrative categories of feedback.
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Administrative Categories of Feedback			
Error	Description	Feedback	Description
No work done since last review	The student has made no changes since the last time he asked for the tutor to review his work.	Mastermind	Tell the student that he has done no work and that a substantial amount of work needs to be completed before review.  Example: You have done no work since I

			last reviewed your work. Please try and correct at least three journal entries before asking me to review your work again.
All work is not complete but a substantial amount of work has been done	If a designer wants to give an interim report of how the student is doing before everything is done, they he would use incomplete--continue.	Incomplete-continue	State that the student has not completed all of the work required, but you will review what the student has done so far.  Example: It looks like you have not finished journalizing, but I will review what you have done up to this point. The first three entries are correct.
All work is not complete and a substantial amount of work is not complete	If a user has not completed enough work to receive feedback, this category is used.	Incomplete-stop	State that nothing has been attempted and point to the first action to be taken.  Example: It looks like you have done no work journalizing. Why don't you start by trying to journalize the fax purchase.

The administrative and the educational categories of feedback account for every piece of feedback a designer can write and a student can receive. To

provide a better understanding of how the feedback works together, an example is provided below.

### Feedback Example

- 5 The following example is a GBS training application in which new finance professionals are taught the fundamentals of finance management. A student has a toolbar to navigate and also to access some of the application-level features of the application. The toolbar is the L-shaped object across the top and left of the interface. The top section of the toolbar allows the user to navigate to tasks within
- 10 the current Activity. The left section of the toolbar allows the student to access other features of the application, including feedback. The student can have his deliverables analyzed and receive feedback by clicking on a team button.

- In this task, the student must journalize twenty-two invoices and other source
- 15 documents to record the flow of budget dollars between internal accounts. (Note: "Journalizing", or "Journalization", is the process of recording journal entries in a general ledger from invoices or other source documents during an accounting period. The process entails creating debit and balancing credit entries for each document. At the completion of this process, the general ledger records are used to
- 20 create a trial balance and subsequent financial reports.) The student has several controls on the screen that must be manipulated to complete the task. The upper left area of the screen shows the current transaction. Each transaction has a corresponding journal entry. The bottom of the screen shows the current journal entry. The Top two lines of the journal entry are for Debits (DR) and the bottom
- 25 two lines are for Credits (CR). As the student uses the 'Back' and 'Next' buttons to page through the transactions, the journal entry is also paged to stay in sync.

- Figure 12 is a GBS display in accordance with a preferred embodiment. The upper right area of the screen shows the account list. There are four types of accounts:
- 30 Assets, Liabilities & Equity, Revenues, and Expenses. The user clicks on one of the tabs to show the accounts of the corresponding type. The student journalizes a

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Figure 17 illustrates a feedback display in accordance with a preferred embodiment. After attempting to journalize the first three transactions, the student submits his work and receives the feedback depicted in Figure 17. The feedback starts by focusing the student on the area of work being evaluated. The ICAT states that it is only looking at the first three journal entries. The feedback states that the first two entries are completely wrong, but the third is close. If the student had made large mistakes on each of the first three transactions, then the ICAT may have given redirect feedback, thinking a global error occurred. The third bullet point also highlights how specific the feedback can become, identifying near misses.

Figures 18 and 19 illustrate a feedback display in accordance with a preferred embodiment.

As a student attempts to correct transactions one and two unsuccessfully, the tutor starts to provide hints, stating that the student should debit an asset account and credit an equity account. The ICAT continues to focus on the errors in the first three source documents and is giving progressively more specific hints.

Figure 20 illustrates a feedback display in accordance with a preferred embodiment. With the specific hints provided as illustrated in Figure 19, the student correctly journalizes the source document. The ICAT, however, continues to focus the student on these first three journal entries as illustrated in Figure 20. The student finally completes the first three entries correctly. The feedback illustrated in Figure 20 informs the student of his success and instructs him to try to complete the rest of the transaction before submitting his deliverable again. This example illustrates the use of an effective technique called "baby-stepping". The student is helped through a small portion of the work to get him introduced to the concepts and the interface. After completing this, he is forced to attempt all of the remaining work before getting substantive feedback. This technique can be used to mimic the kind of interactions one could expect to receive from a mentor in real life. The three transactions above show a tiny fraction of the depth of student analysis and richness of remediation that the ICAT is capable of delivering.

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## Activity

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## Task

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financial training program. Students learn finance by managing a simulated bicycle company for three years and using finance to solve business problems. At four places in the course, the students come together to present their analyses of the business. These presentations are live presentations to real business executives.

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In preparation for the pitches, the students complete computer-based modules. There are two major sections to each module, the accounting concepts and the activities. Students learn the concepts and ideas in the accounting concepts and apply the concepts in the activities. All of the modules together represent the different phases associated with running a business: Start Operations, Analyze Operations and Improve Operations. Each computer-based activity represents a business event, such as closing the books of the company. These business events provide context for the content the students learn in the course. In this way, students not only learn what the concepts are but when, how and why they should use them.

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Business Events—Activities	
1. Financial Planning	4. Closing the Books
2. Recording Transactions	5. Analyze the Books
3. Recording Transactions	6. Improve Operations

Figure 21 illustrates a simulation display in accordance with a preferred embodiment.

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To show how the business events impact the company on a day to day basis, students complete a set of deliverables associated with each business event. The business deliverables students create in the training application are varied in form and content. Some example business deliverables are listed below in accordance with a preferred embodiment.

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1. *An analysis of proforma financial statements*

Students perform break-even analysis to determine which of twelve business strategies to pursue.

5 2. *Journal entries*

Student journalize 20 of the transactions which occur in the third year of operations.

3. *Summaries of interviews with employees about operating plan variances*

10 Students get behind the numbers and figure out what is driving the variances.

*Design Scenario*

This Scenario illustrates how the tools are used to support conceptual and detailed design of a BusSim application. Figure 22 illustrates the steps of the first scenario in accordance with a preferred embodiment. The designer has gathered requirements and determined that to support the client's learning objectives, a task is required that teaches journalization skills. The designer begins the design first by learning about journalization herself, and then by using the Knowledge Workbench to sketch a hierarchy of the concepts she want the student to learn. At the most general level, she creates a root concept of 'Journalization'. She refines this by defining sub-concepts of 'Cash related transactions', 'Expense related Transactions', and 'Expense on account transactions'. These are each further refined to whatever level of depth is required to support the quality of the learning and the fidelity of the simulation.

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The designer then designs the journalization interface. Since a great way to learn is by doing, she decides that the student should be asked to Journalize a set of transactions. She comes up with a set of twenty-two documents that typify those a finance professional might see on the job. They include the gamut of Asset, Expense, Liability and Equity, and Revenue transactions. Also included are some documents that are not supposed to be entered in the journal. These 'Distracters' are

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included because sometimes errant documents occur in real life. The designer then uses the Domain Model features in the Knowledge Workbench to paint a Journal. An entity is created in the Domain Model to represent each transaction and each source document.

- 5 Based on the twenty-two documents that the designer chose, she can anticipate errors that the student might make. For these errors, she creates topics of feedback and populates them with text. She also creates topics of feedback to tell the student when they have succeeded. Feedback Topics are created to handle a variety of situations that the student may cause.
- 10 The next step is to create profiles that will trigger the topics in the concept tree (this task is not computational in nature, so the Transformation Component does not need to be configured). A profile resolves to true when its conditions are met by the student's work. Each profile that resolves to true triggers a topic.
- 15 To do some preliminary testing on the design, the designer invokes the Student Simulator Test Workbench. The designer can manipulate the Domain Model as if she were the student working in the interface. She drags accounts around to different transactions, indicating how she would like them journalized. She also enters the dollar amounts that she would like to debit or credit each account. She submits her actions to the component engines to see the feedback the student would
- 20 get if he had performed the activity in the same way. All of this occurs in the test bench without an application interface.

The last step in this phase is low-fi user testing. A test student interacts with a PowerPoint slide or bitmap of the proposed application interface for the

- 25 **Journalization Task.** A facilitator mimics his actions in the test bench and tells him what the feedback would be. This simplifies low-fi user testing and helps the designer to identify usability issues earlier in the design when they are much cheaper to resolve.

### ***Build Scenario***

Figures 23 and 24 illustrate the steps associated with a build scenario in accordance with a preferred embodiment. The instructional designer completes the initial interaction and interface designs as seen in the previous Scenario. After low-fi user testing, the Build Phase begins. Graphic artists use the designs to create the bitmaps that will make up the interface. These include bitmaps for the buttons, tabs, and transactions, as well as all the other screen widgets. The developer builds the interface using the bitmaps and adds the functionality that notifies the Domain Model of student actions. Standard event-driven programming techniques are used to create code that will react to events in the interface during application execution and pass the appropriate information to the Domain Model. The developer does not need to have any deep knowledge about the content because she does not have to build any logic to support analysis of the student actions or feedback. The developer also codes the logic to rebuild the interface based on changes to the domain model.

A few passes through these steps will typically be required to get the application communicating correctly with the components. The debug utilities and Regression Test Workbench streamline the process. After the application interface and component communication are functioning as designed, the task is migrated to Usability testing.

### ***Test Scenario***

This scenario demonstrates the cycle that the team goes through to test the application. It specifically addresses usability testing, but it is easy to see how the tools also benefit functional and cognition testing. Again, we will use the Journalization Task as an example. Figure 24 illustrates a test scenario in accordance with a preferred embodiment. The test students work through the journalization activity. One of the students has made it over half way through the task and has just attempted to journalize the sixteenth transaction. The student submits to the Financial Coach, but the feedback comes back blank. The student

notifies the facilitator who right-clicks on the Financial Coach's face in the feedback window. A dialog pops up that shows this is the twenty-seventh submission and shows some other details about the submission. The facilitator (or even the student in recent efforts) enters a text description of the problem, and fills out some other fields to indicate the nature and severity of the problem. All the student's work and the feedback they got for the twenty-seven submissions is posted to the User Acceptance Test (UAT) archive database.

The instructional designer can review all the student histories in the UAT database and retrieve the session where the student in question attempted the Journalization Task. The designer then recreates the problem by replaying the student's twenty-seven submissions through the component engines using the Regression Test Workbench. The designer can then browse through each submission that the student made and view the work that the student did on the submission, the feedback the student got, and the facilitator comments, if any. Now the designer can use the debugging tools to determine the source of the problem. In a few minutes, she is able to determine that additional profiles and topics are needed to address the specific combinations of mistakes the student made. She uses the Knowledge Workbench to design the new profiles and topics. She also adds a placeholder and a script for a video war story that supports the learning under these circumstances. The designer saves the new design of the task and reruns the Regression Test Workbench on the student's session with the new task design. After she is satisfied that the new profiles, topics, and war stories are giving the desired coverage, she ships the new task design file to user testing and it's rolled out to all of the users.

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This example illustrates how a high effort, uncertain process (that once took days) can be reduced to a few hours using the BusSim Toolset. Cycle time can be reduced dramatically, and complexity, risk and difficulty can be almost eliminated. It shows the sharp contrast with the traditional development approach where new designs and new code can have many unintended consequences that are difficult to test.

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***Execution Scenario: Student Administration***

Figure 25 illustrates how the tool suite supports student administration in accordance with a preferred embodiment. When a student first enters a course she performs a pre-test of his financial skills and fills out an information sheet about his job role, level, etc. This information is reported to the Domain Model. The Profiling Component analyzes the pre-test, information sheet, and any other data to determine the specific learning needs of this student. A curriculum is dynamically configured from the Task Library for this student. The application configures its main navigational interface (if the app has one) to indicate that this student needs to learn Journalization, among other things.

As the student progresses through the course, his performance indicates that his proficiency is growing more rapidly in some areas than in others. Based on this finding, his curriculum is altered to give him additional Tasks that will help him master the content he is having trouble with. Also, Tasks may be removed where he has demonstrated proficiency. While the student is performing the work in the Tasks, every action he takes, the feedback he gets, and any other indicators of performance are tracked in the Student Tracking Database. Periodically, part or all of the tracked data are transmitted to a central location. The data can be used to verify that the student completed all of the work, and it can be further analyzed to measure his degree of mastery of the content.

***Execution Scenario: Student Interaction***

Figure 26 illustrates a suite to support a student interaction in accordance with a preferred embodiment. In this task the student is trying to journalize invoices. He sees a chart of accounts, an invoice, and the journal entry for each invoice. He journalizes a transaction by dragging and dropping an account from the chart of accounts onto the 'Debits' or the 'Credits' line of the journal entry and entering the dollar amount of the debit or credit. He does this for each transaction.

5 the student is ready, he submits the work to a simulated team member for review.

10

15 topics in the Remediation Component. After the Profiling Component completes, the Remediation Component is invoked. The remediation algorithm searches the

20 and presented to the student. The text feedback helps the student localize his  
journalization errors and understand why they are wrong and what is needed to

journalization. He is also presented with links to the reference materials that

The Analysis-Interpretation cycle ends when any coach items that result in updates to the Domain Model have been posted and the interface is redrawn to represent the

new domain data. In this case, the designer chose to highlight with a red check the  
30 transactions that the student journalized incorrectly.

### III. The Functional Definition of the ICAT

This section describes the feedback processes in accordance with a preferred embodiment. For each process, there is a definition of the process and a high-level description of the knowledge model. This definition is intended to give the reader a baseline understanding of some of the key components/objects in the model, so that he can proceed with the remaining sections of this paper. Refer to the Detailed Components of the ICAT for a more detailed description of each of the components within each knowledge model. To gain a general understanding of the ICAT, read only the general descriptions. To understand the ICAT deeply, read this section and the detailed component section regarding knowledge models and algorithms. These processes and algorithms embody the feedback model in the ICAT. There are six main processes in the ICAT, described below and in more detail on the following pages.

#### 15 Remediation Process Diagram

Figure 27 illustrates the remediation process in accordance with a preferred embodiment. Remediation starts as students interact with the application's interface (process #1). As the student tries to complete the business deliverable, the application sends messages to the ICAT about each action taken (process #2). When the student is done and submits work for review, the ICAT compares how the student completed the activity with how the designer stated the activity should be completed (this is called domain knowledge). From this comparison, the ICAT get a count of how many items are right, wrong or irrelevant (process #3). With the count complete, the ICAT tries to fire all rules (process #4). Any rules which fire activate a coach topic (process #5). The feedback algorithm selects pieces of feedback to show and composes them into coherent paragraphs of text (process #6). Finally, as part of creating feedback text paragraphs, the ICAT replaces all variables in the feedback with specifics from the student's work. This gives the feedback even more specificity, so that it is truly customized to each student's actions.

### ***1. Student interacts with interface to create business deliverable***

#### **Description**

The student completes the deliverables of the Task by interacting with the interface objects. These actions may be button clicks, dragging of text, selection of items from a list, etc. An example is the Journalization task shown below. Figure 28 illustrates a display of journalization transactions in accordance with a preferred embodiment. To interact with the display, the student must journalize the twenty-four transactions presented. To journalize a transaction, the student clicks the “next” and “previous” buttons to move between transactions. Once at a transaction, the student clicks and drags an account name from the chart of accounts--which is split into Assets, Liabilities, Revenues and Expenses--onto the debit or credit side of the journal entry. Once the journal entry has been made, the student must type in how much to debit or credit. Each one of these buttons, draggable items, and text fields are interface objects which can be manipulated.

#### **Knowledge Model**

##### **Interface Objects**

In any GBS Task, the student must manipulate controls on the application interface to complete the required deliverables. Figure 29 illustrates the objects for the journalization task in accordance with a preferred embodiment.

The following abstract objects are used to model all the various types of interface interactions.

#### **25 SourceItem**

A SourceItem is an object the student uses to complete a task. In the journalization example, the student makes a debit and credit for each transaction. The student has a finite set of accounts with which to respond for each transaction. Each account that appears in the interface has a corresponding SourceItem object. In other words, the items the student can manipulate to complete the task (account names) are called SourceItems.

## Source

A Source is an object that groups a set of SourceItem objects together. Source objects have a One-To-Many relationship with SourceItem objects. In the journalization example, there are four types of accounts: Assets, Liabilities and Equity, Revenues, and Expenses. Each Account is of one and only one of these types and thus appears only under the appropriate tab. For each of the Account type tabs, there is a corresponding Source Object.

## 10 Target

A Target is a fixed place where students place SourceItems to complete a task. In the journalization example, the student places accounts on two possible targets: debits and credits. The top two lines of the journal entry control are Debit targets and the bottom two lines are Credit targets. These two targets are specific to the twelfth transaction.

## TargetPage

A TargetPage is an object that groups a set of Target objects together. TargetPage objects have a One-To-Many relationship with Target objects (just like the Source to SourceItem relationship). In the journalization example, there is one journal entry for each of the twenty-two transactions. For each journal entry there is a corresponding TargetPage object that contains the Debits Target and Credits Target for that journal entry.

## 25 2. *Reporting student actions to the ICAT*

### Description

As the student manipulates the application interface, each action is reported to the ICAT. In order to tell the ICAT what actions were taken, the application calls to a database and asks for a specific interface control's ID. When the application has the ID of the target control and the SourceItem control, the application notifies the ICAT about the Target to SourceItem mapping. In other words, every time a student

manipulates a source item and associates it with a target (e.g., dragging an account name to a debit line in the journal), the user action is recorded as a mapping of the source item to the target. This mapping is called a UserSourceItemTarget. Figure 30 illustrates the mapping of a source item to a target item in accordance with a preferred embodiment.

### *3. Student submits deliverables to one team member*

#### **Description**

When the student is ready, he submits his work to one of the simulated team members by clicking on the team member's icon. When the ICAT receives the student's work, it calculates how much of the work is correct by concept. Concepts in our journalization activity will include Debits, Credits, Asset Accounts, etc. For each of these concepts, the ICAT will review all student actions and determine how many of the student actions were correct. In order for the ICAT to understand which targets on the interface are associated with each concept, the targets are bundled into target groups and prioritized in a hierarchy. Figure 31 illustrates target group bundles in accordance with a preferred embodiment. For each target group--or concept, such as debit--a number of aggregate values will be calculated. These aggregate values determine how many student actions were right, wrong or irrelevant.

#### **Knowledge Model**

##### **TargetGroup**

A TargetGroup object represents a concept being learned. It is a group of Target objects related on a conceptual level. The TargetGroup objects in a Task are arranged in a hierarchy related to the hierarchy of concepts the student must learn. By analyzing the student's responses to the Targets in a TargetGroup, the ICAT can determine how well a student knows the concept. By utilizing the conceptual hierarchy of TargetGroups the ICAT can determine the most appropriate remediation to deliver to help the student understand the concepts.

### TargetGroup Hierarchy

The TargetGroup objects in a Task are arranged in a hierarchical tree structure to model the varying specificity of concepts and sub-concepts being learned in the Task. The designer defines the parent-child relationships between the TargetGroups to mimic the relationships of the real world concepts. This hierarchy is used in the determination of the most appropriate feedback to deliver. Concepts that are higher (more parent-like) in the TargetGroup structure are remediated before concepts that are modeled lower (children, grandchildren, etc.) in the tree. Figure 32 illustrates a TargetGroup Hierarchy in accordance with a preferred embodiment.

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In the journalization example, the main concept being taught is journalization. The concept of journalization can be divided into more specific sub-concepts, for example journalizing cash-for-expense transactions and journalizing expense-on-account transactions. These may further be divided as necessary. The designer teaches this conceptual knowledge to the ICAT by creating a TargetGroup called "Journalizing Transactions" with two child TargetGroups "Journalizing Cash for Expense Transactions" and "Journalizing Expense On Account Transactions". The top-most TargetGroup in the Task, "Journalizing Transactions" contains all of the transactions in the Task. Child target groups will include just the first three transactions and transactions four to twenty.

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Therefore when the when the ICAT determines how much of the task is correct, it will calculate values for the first three journal entries and the next sixteen.

Calculating these two separate numbers will allow the ICAT to provide specific feedback about the first three and separate feedback about the next sixteen transactions. Here is a section of the target group hierarchy for the journalize task. Figure 33 illustrates a small section the amount of feedback in accordance with a preferred embodiment. By analyzing the responses to the targets in the each of the targetgroups, we can determine how many of the transactions the student has attempted, whether mistakes were made, what the mistakes were, etc. We can then assemble feedback that is very specific to the way the student completed the

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deliverables. By analyzing the student's responses to a group of conceptually related requests, we can determine the degree of success with which the student is learning the concept.

#### 5    **4. ICAT analyzes deliverables with Rules**

##### Description

After the ICAT has calculated the aggregate values for the student's deliverables, it analyzes the deliverables by attempting to fire all of the Rules for that task. Rules that can fire, activate CoachTopics. Figure 34 illustrates an analysis of rules in accordance with a preferred embodiment.

#### 10    **5. Select appropriate remediation coach topics**

##### Description

Once all possible coach topics are activated, a feedback selection analyzes the active pieces of remediation within the concept hierarchy and selects the most appropriate for delivery. The selected pieces of feedback are then assembled into a cohesive paragraph of feedback and delivered to the student. Figure 35 illustrates a feedback selection in accordance with a preferred embodiment.

#### 20    **Feedback Selection Algorithm**

After the ICAT has activated CoachTopics via Rule firings, the Feedback Selection Algorithm is used to determine the most appropriate set of CoachItems (specific pieces of feedback text associated with a CoachTopic) to deliver. The Algorithm accomplishes this by analyzing the concept hierarchy (TargetGroup tree), the active CoachTopics, and the usage history of the CoachItems. Figure 36 is a flowchart of the feedback logic in accordance with a preferred embodiment. There are five main areas to the feedback logic which execute sequentially as listed below. First, the algorithm looks through the target groups and looks for the top-most target group with an active coach topic in it. Second, the algorithm then looks to see if that top-most coach item is praise feedback. If it is praise feedback, then the student has correctly completed the business deliverable and the ICAT will stop and return that

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### *The Steps Involved in Creating Feedback*

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There are seven major steps involved in developing feedback for an application.

- 25 First, creating a strategy — The designer defines what the student should know.  
Second, limit errors through interface — The designer determines if the interface will identify some low level mistakes.  
Third, creating a target group hierarchy — The designer represents that knowledge in the tutor.
- 30 Fourth, sequencing the target group hierarchy — The designer tells the tutor which concepts should be diagnosed first.

**Sixth, writing Levels of Feedback** — The designer writes different levels of feedback in case the student makes the same mistake more than once.

- ## Creating a Feedback Strategy

*What should the student know after using the application?*

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30 *How will a novice try and complete the task?*

**Designers should start by defining how they believe a novice will try and complete**

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## 10

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### Limit Errors Through Interface

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## 10

be easier for the designer and developer to catch them at this level than to leave them for the ICAT.

## 15

approach which can make the job of creating a coherent feedback approach more difficult.

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## 30

It is very important that the student know what type of remediation he is going to get

from each source of information. Interface based remediation should look and feel like system messages. They should use a different interface from the ICAT remediation and should have a different feel. In the journalization task described throughout this paper, there is a system message which states "Credits do not equal debits." This message is delivered through a different interface and the blunt short sentence is unlike all other remediation.

The motivation for this is that low level data entry mistakes do not show misunderstanding but instead sloppy work. Sloppy-work mistakes do not require a great deal of reasoning about why they occurred instead, they simply need to be identified. High-level reasoning mistakes, however, do require a great deal of reasoning about why they occurred, and the ICAT provides tools, such as target groups, to help with complex reasoning. Target group hierarchies allow designers to group mistakes and concepts together and ensure that they are remediated at the most appropriate time (i.e., Hard concepts will be remediated before easy concepts). Timing and other types of human-like remediation require the ICAT; other low-level mistakes which do not require much reasoning include:

#### **Incomplete**

If the task requires a number of inputs, the interface can check that they have all been entered before allowing the student to proceed. By catching empty fields early in the process, the student may be saved the frustration of having to look through each entry to try and find the empty one.

#### **Empty**

A simple check for the system is to look and see if anything has been selected or entered. If nothing has been selected, it may be appropriate for the system to generate a message stating "You must complete X before proceeding".

#### **Numbers not matching**

Another quick check is matching numbers. As in the journalization activity, is often

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useful to put a quick interface check in place to make sure numbers which must match do. Small data entry mistakes are often better remediated at the interface level than at the tutor or coach level (when they are not critical to the learning objectives of the course).

5

There are two main issues which must be remembered when using the interface to remediate errors. First, make sure the interface is remediating low level data entry errors. Second, make sure the feedback looks and feels different from the ICAT feedback. The interface feedback should look and feel like it is generated from the system while the ICAT feedback must look as if it were generated from an intelligent coach who is watching over the student as he works.

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### *Creating the Target Group Hierarchy*

Target groups are sets of targets which are evaluated as one. Returning to the severity principle of the feedback theory, it is clear that the tutor needs to identify how much of the activity the student does not understand. Is it a global problem and the student does not understand anything about the activity? Or, is it a local problem and the student simply is confused over one concept? Using the feedback algorithm described earlier, the tutor will return the highest target group in which there is feedback. This algorithm requires that the designer start with large target groups and make sub-groups which are children of the larger groups. The ICAT allows students to group targets in more than one category. Therefore a debit target for transaction thirteen can be in a target group for transaction thirteen entries as well as a target group about debits and a target group which includes all source documents. Target should be grouped with four key ideas in mind. Target groups are grouped according to:

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Concepts taught

Interface constraints

Avoidance of information overload

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Positive reinforcement

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The most important issue when creating target groups is to create them along the concepts students need to know to achieve the goal. Grouping targets into groups which are analogous to the concepts a student needs to know, allows the tutor to review the concepts and see which concepts confuse the student. As a first step, a  
5 designer should identify in an unstructured manner all of the concepts in the domain. This first pass will be a large list which includes concepts at a variety of granularities, from small specific concepts to broad general concepts. These concepts are most likely directly related to the learning objectives of the course.

10 With all of the concepts defined, designers need to identify all of the targets which are in each target group. Some targets will be in more than one target group. When a target is in more than one target group, it means that there is some type of relationship such as a child relationship or a part to whole relationship. The point is not to create a structured list of concepts but a comprehensive list. Structuring them  
15 into a hierarchy will be the second step of the process.

In the journalization activity, the largest concept is the recording a transaction. Other important ideas are debits and credits. Debit and credit targets, however, are included in the overall transaction target group which means that it is either a part-  
20 whole relationship or a child relationship. Figure 38 is a block diagram of the hierarchical relationship of a transaction in accordance with a preferred embodiment.

### **Concepts Taught: Part-whole Concepts**

With all of the target groups laid out, the designer needs to identify the relationships  
25 between concepts. One type of relationship is the part-whole relationship. Part-whole relationships--as the name denotes--identified which sub-components make up larger concepts. Identifying these relationships is important because the tutor will want to see if the student does not understand the whole concept or just one part. If there are no major errors in the concept as a whole, then the tutor will look  
30 to see if the student made any major errors in one part of the concept.

Example:

In the journalizing activity, there will be a target group called transaction. In transaction, there are two parts: debits and credits. When the tutor reviews the student's work, if there are no problems with the target group transactions, then the tutor will go to the next level and look for errors in the target group debits and credits. Because debits and credits are included in an overall transaction, there is a part-whole relationship to the concept transaction.

**Concept Taught: Child Concepts**

In addition to part-whole relationships, designers need to identify child-parent relationships. In contrast to part-whole relationships, child-parent relationships define instances of abstract concepts. An example is "The dictionary is a book". "Dictionary" is a child concept to "book". The "dictionary" concept has all of the attributes of the "book" concept, and it is an instance of the concept which means that it contains extra attributes. Students may understand the concept in general but may be confused about a particular instance.

Example:

In the journalization activity, the concept transaction can be broken down into two sections: the debit and the credit. And each of those can be specialized into specialization categories, such as a credit to "Accounts payable". Students may not be confused about debits but the instance "Accounts Payable".

**Interface Constraints**

**Interface Constraint: Business Deliverable**

When creating target group hierarchies, designers need to consider the type of deliverable the student is creating. For each of the sections of the deliverable, the designer needs to create a target group. The target groups should contain an orderly structure, such as moving from top to bottom. Reviewing the deliverable in the

order it is created structures the critique so that students know where to look next, after receiving feedback. In the current Intelligent Tutoring Agent, this structuring of feedback around the student-created deliverable can be accomplished in two ways. First, the designer can make every section of the deliverable a target. In addition, the designer can make some sections targets and some modifying attributes. Modifying attributes can be remediated on specifically, or in conjunction with the target.

In the journalization activity, the sections of the product--the journal entry--mirrors the concepts involved--debits and credits. But there are a few extra items on the journal which are (in most cases) not involved in the main concepts being taught, and these are the dollar amounts to be journalized. The dollar amounts which are journalized are associated with the journal entry as an attribute. Attributes modify the source item (account name), which makes it possible to tell if the source item is correct alone or with the attribute attached. As a designer, feedback should be created which takes all of this into account. Students should be told if they have the journal entry correct and the amount wrong, or if they have the whole thing wrong.

#### **Interface Constraint: Screen Space**

Many times one concept will span many sections of the interface. It is important to group the target groups so that they are interface specific. Therefore, even though one product may span multiple interfaces, the target groups should be centered around the interfaces so that the students receive feedback only about what they can see.

In the journalization activity, the sections of the deliverable--the collection of journal entries in the ledger -- span many separate interfaces. Each source document must be seen individually. Therefore, some target groups are organized across all source documents -- such as all debits -- and others are specific to the individual source documents -- such as that source document's debits. The target group's hierarchy

must include a section for across source documents -- across interfaces -- and those within one source document -- one interface.

### Information Overload

- 5 As with any real-life tutor, you do not want to give too much information for the student to digest at once. If there are twenty-five problems, the tutor should not give feedback about all errors simultaneously. Instead, the tutor should give feedback about just two or three things which the student can correct before asking for more feedback.

- 10 In the journalization activity, there are a limited number of targets on the interface at one time--one debit and one credit. But if it were the whole General Lcdger, it could have too many pieces of feedback for the student to digest at once and could overwhelm the student. In this case, the designer should scale the feedback so that
- 15 just a handful come back at once. This is best done by having small target groups defined, but can also be done by identifying to the tutor how many different pieces of remediation are appropriate to deliver at one time.

### Positive Reinforcement

- 20 In addition to creating target groups which are small in size, designers may want to create target groups which evaluate the first few steps a student makes. These early target groups will allow the student to see if he is on track and understand the goal of the interaction. This is, in general, a good remediation strategy, but may not be relevant in all learning situations.

- 25 In the journalization activity, there are twenty source documents to journalize. Students should NOT be encouraged to ask for feedback at every step, but when they have completed all of their work. This will ensure that students try and learn all of the information first and not rely completely on the hints of the tutor. But, target
- 30 groups defined for just the first three entries allow for feedback and hints to be provided at the onset of the task, diminishing once these entries are correct.

### *Sequencing the Target Group Hierarchy*

For feedback to be as effective as possible, it needs to provide the right information at the right time. If feedback is given too early, it is confusing; if feedback is given too late it is frustrating. In the ICAT, feedback is returned according to Target Groups. The tutor will look at the highest target group, if there is no feedback in that target group, the tutor will look at the children target groups in order of priority.

Figure 39 is a block diagram illustrating the feedback hierarchy in accordance with a preferred embodiment. In Figure 39, the tutor will first look for any relevant feedback to be delivered in target group #1A. If there is nothing there, then the tutor will look in the highest prioritized child target group—in the B tier. If there is nothing in that target group, then the tutor will look in the highest child target group of target group #1B which is target group #1C. Because the target group priority determines where the tutor looks for feedback within tier, a great deal of thought needs to be given to what comprises a target group and how they are structured. There are four guiding principles which will help structure target groups to provide the right information at the right time and help the student make the most of the information provided.

20

#### **Positive Reinforcement First**

Designers should identify the first few components a student will try and complete first and sequences them first. This target group will evaluate just the first few moves a student makes and will tell him how he is doing and how to apply the knowledge gained from the first few steps to the rest of the work he has to do.

25

In the journalization activity, students need to have reinforcement that they are on the right track before trying all of the journal entries. Therefore, the first three are grouped together and students can feedback on how they completed this sub-group before having to complete the rest. Completing this subsection gives students the positive reinforcement they need to complete the rest.

30

### Easy Before Hard

- If all of the target groups are of equivalent size, designers need to sequence easier concepts before more complicated concepts. By placing easier concepts first, a student will gain confidence in their understanding of the domain and in their ability to complete the deliverable. In addition, most complicated concepts are built on easier ones so that presenting easier concepts first will allow the student to gain the experience they need to complete the most complicated concepts. In the journalization activity, two legged journal entries are inherently easier than three legged and four legged journal entries. Therefore when a designer must sequence target groups of equal size, the designer should sequence the two legged journal entries before the three and four legged entries.

### First Things First

- Besides sequencing easier concepts before hard concepts, another strategy is to sequence target groups in order that they need to be completed. If completing one section of the deliverable is a prerequisite for completing another section of the deliverable, it makes sense to sequence those targets first. In the journalization activity, a source document needs to be journalized in terms of the account name and in terms of the dollar amount. However, the account name must be identified before the amount is entered. It makes no difference whether the dollar figure of the account is right or wrong, until the student has the correct account name.

### *Writing Feedback*

- Creating and structuring target group hierarchies determines what is evaluated and the order the feedback is returned. Once the hierarchy has been created and structured, designers need to write feedback which will help the student complete his goal. Going back to the goals of the tutor as educator, feedback needs to accomplish the following goals:
- Identify concepts students do not understand
  - Identify student mistakes

Prompt students to reflect on their mistakes

Reinforce correct concepts and ideas

- 5 These goals can be thought of in two sections. The first two are evaluative and the second two are instructive. Evaluation and instruction are two of the three main components of a piece of feedback text. The third component is Scope. These three components are described in more detailed below, beginning with Scope, as it is generally the first portion of a piece of feedback text.

10 What the Feedback is Evaluating (Scope)

- The most important information feedback provides a student is what the tutor is reviewing. In most instances, the student will have completed lots of different actions before asking the tutor to review his work. Because the student has completed a lot of different actions, the tutor first needs to describe what portion of the activity or deliverable is being reviewed. There are generally three ways to scope what the tutor is reviewing.
- 15

All work

- The tutor is looking at everything the student did. Some instances when feedback should look at everything the student has done are praise level feedback and redirect level feedback. **I looked at all of the journal entries** and there are problems in many of them. Why don't you....
- 20

A localized area of work

- The tutor is looking at a subset of work the student completed. The greatest use of localized scoping is focus feedback. The feedback is focusing the student on one area of difficulty and asking him to correct it. **I am looking at the first five journal entries you made**, and here are the first three problems I found. The first...
- 25

30 A specific problem or error

The tutor is focusing on one error and/or problem and helping the student understand

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that error. Specific problem scoping is good for classic mistakes a student may make and the designer may want to remediate. **In the first journal entry**, you incorrectly debited Accounts Payable. Review that transaction...

5 How the Student Did (Evaluation)

The second section of the feedback text should describe how the student did. This is where the severity principle is applied and the feedback is either redirect, focus, polish or praise.

10 Redirect

Redirect feedback is appropriate for very severe errors: severe mistake sand misconceptions. This degree of severity can be assessed aggregately by recognizing there are problems throughout the student's work or it can be done specifically by recognizing some basic items are incorrect.

15

Example:

I am looking at the first five journal entries you made, and **there are problems in most of them**. Why don't you... I am looking at the first five journal entries you made, and **you have made some basic mistakes with debits and credits**. Why don't you...

20

Focus

Focus feedback is appropriate for localized mistakes or misconceptions. Focus level mistakes can be identified aggregately by identifying an area in which there are a number of mistakes or specifically by identifying that some of the building block ideas are wrong.

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Example:

I am looking at the first five journal entries you made, and **there are problems in many of the debits**. Why don't you...

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## 5 Polish

10 Example:

## Praise

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I am looking at the first five journal entries you made, and **they are all correct.**  
remember...

## Mastermind

30 more work completed before providing feedback.

**You have not changed much of your work since the last time you asked me to review it. Review...**

5 Incomplete feedback is reserved for instances where the student has not completed all of the required work. It should be remembered that sometimes it is desired to give substantive feedback before everything is complete so the student learns the process and concepts before trying to complete the whole deliverable.

**You have not done all of your work. I would like you to try completing all journal entries before asking for my review.**

15 The final piece of information the student needs is what to do next. The student knows what the tutor reviewed and knows how he performed. The only thing the student does not know is what to do next. The type of instruction does not have to correspond with the severity of the error. The instructions can be mixed and matched with the type of error. Some of the actions a student could be asked to  
20 perform are as follows.

If the tutor recognizes that there are many errors throughout the deliverable, the tutor may suggest that the student go through a review of the supporting materials provided to gain an understanding of the ideas and skills needed to complete the task.

There are problems in many journal entries, why don't you review how to  
30 journalize transactions and then review your journal entries.

Review a section of the student's work

If the student has many errors in one section, then the tutor may suggest that the student go and review that section of their work.

5 Example:

There are problems in the first five journal entries, **why don't you review them.**

Review work with a hint

10 If there is a certain idea or concept which the tutor believes the student does not understand, then the tutor may give a hint in the form of a question or statement for the student to think about before trying to fix the problems.

Example:

15 There are problems in the first five journal entries. It looks like you have made some errors with the expense debits. **Remember that expenses are not capitalized. Why don't you review the first five journal entries looking for journal entries which contained incorrect debits to expense accounts.**

Review work looking for type of error

20 If there is a specific type of error that the student has made throughout his work, then the tutor may tell the student the specific type of error and ask him to go through his work correcting this error.

Example:

25 There are problems in the first five journal entries. **You have switched all of your journal entries on account debits. Why don't you go and fix them.**

Review work looking for specific error

30 If there is a specific error that the student has committed, the tutor may tell the student the specific error committed and where the error is.

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Example:

There is a problem with your third journal entry. **The debit should not be "Accounts Payable."**

- 5    Review work because it is correct and the student will want to use this analysis technique in the future.

Example:

- 10    Your first three journal entries are correct. **Remember that the major distinction between paying for something "On Account" or in cash. This is a distinction you will need to make in the future.**

Do more work

- 15    If it can be determined that the student is simply asking for feedback to "Cheat" his way through the course, feedback should be provided to tell the student that he needs to try and correct many more entries before receiving substantive feedback.

Example:

- 20    You have not changed much of your work since the last time you asked me to review it. Please review all of your journal entries and **correct many of them.**

Complete your work

- 25    When it can be determined that all of the work which should be complete is not, the feedback needs to tell the student to complete the work required.

Example:

- 30    You have not completed all of your work. **I would like you to try completing all journal entries before asking for my review.**

### *Writing Levels of Feedback*

Even with effective feedback, students will often make the same types of mistakes again or in different situations. The question is what to tell the student the second  
5 time he makes the same or similar mistakes. We assume that telling the student the same thing over and over is not the right answer. Therefore instead of telling the student the same thing, the feedback cycles to a lower, or secondary, level. At this time, we believe that three levels of feedback is appropriate for most instances. If the target group is particularly complex, however, additional levels of feedback may  
10 be required.

#### First Level of Feedback

The first level of feedback should focus more on telling the student what is wrong and letting the student try and figure it out on his own. Therefore using the  
15 paradigm described above, the student should be told what the tutor is reviewing, how he did and asked to retry it or referred to some reference which could be used to find the answer.

#### 20 Example:

There are problems in many journal entries. Why don't you review how to journalize transactions and then review your work.

#### Second Level of Feedback

25 The second level of feedback should give hints and provide pieces of the puzzle. I can be assumed that students cannot figure out the problem on their own and need some help. It is appropriate at this point to ask the student to review their work with a specific hint in mind or with a question to think about. Also, if there are specific points in the reference system to review, this is the time to provide them.

30

Example:

- There are problems in the first five journal entries. It looks like you have made some errors with expense debits. Remember that expenses are not capitalized. Why don't you review the first five journal entries looking for journal entries which
- 5 contain incorrect debits to expense accounts.

Third Level of Feedback

- The third level of feedback is appropriate for examples. Use the parameter substitution language to insert an example of an error they made into the feedback.
- 10 Walk the student through the thought process he should use to solve the problem and provide an example of how they did the work right and how they did the work wrong.

Example:

- 15 There are problems in many of your journal entries. It looks like you have made some errors distinguishing between "on account" and "cash" credits. In particular, you characterized journal entry #12 as a cash purchase when in fact it is an "on account" purchase. Remember bills which are not paid immediately are paid on account.

20

**Writing Rules**

- With the hierarchies created and sequenced and the feedback written, the designer is ready to write rules. Rules fire the particular pieces of feedback the student reads. To write effective rules, designers must realize the piece of feedback and the rule are
- 25 one and the same. The only difference is the language used. The feedback is written in English and the rules are written as patterns.

Example rule:

- If the student has attempted all of the first three journal entries
- 30 And they all contain at least one mistake

**Then** provide feedback “In the first three journal entries you have made at least one mistake in each. Why don’t you review them and see if you can find the mistakes.”

- 5 In the above example, the rules has two conditions (attempt all three journal entries **and** have at least one mistake in each). The feedback is an explicit statement of that rule. The feedback states “In the first three journal entries you have made at least one mistake in each. Why don’t you review them and see if you can find any mistakes.”

- 10 The rule and the feedback are exactly the same. Keeping the rules and the feedback tightly linked ensures that the student receives the highest quality feedback. The feedback exactly explains the problem the rules found. If the feedback is more vague than the rule, then the students will not understand the exact nature of the problem. The feedback will simply hint at it. If the feedback is more specific than  
15 the rule, students will become confused. The student may not have made the specific error the feedback is referring to under the umbrella rule.

#### Types of Rules

- Because the rules need to map to the feedback, there will be six types of rules  
20 associated with the six types of feedback: Praise, Polish, Focus, and Redirect, along with Mastermind and Incomplete.

#### Praise

- Praise rules need to look for one hundred percent correct and NO errors. If the rule  
25 does not explicitly look for no errors, the rule will also fire when the student has all of the right answers but also some of the wrong ones.

- If 100% of the targets in the first three journal entries are correct  
30 **And** they all contain no mistakes  
**Then** provide praise feedback

- Praise rules can be applied in many places other than the highest task level. Praise rules can fire for instances where a student got an item right. In general, these rules should be written for any instance which poses a difficult problem and a student may need reinforcement as to how to complete the process and complete the deliverable.

### Polish

- Polish rules need to fire when almost everything in the target group is correct and the student is making small and insignificant mistakes.

If 80%-99% of the targets in the first three journal entries are correct

And the first three journal entries have been tried

- Then provide polish feedback

- This polish rule shows two things. First, the rule is scoped so that it will not fire when any of the first three journal entries have not been attempted. In addition, the rule will not fire if all of the journal entries are 100% correct. With these boundaries in place the rule will only fire when the student has attempted all of the first three journal entries and they are 80%-99% correct. **Note: The determination of the exact percentages which must be correct to receive “polish” versus “focus” or “redirect” feedback will be determined by the designer, and are most likely specific to the particular task being completed.**

### Focus

Focus rules are the most common type of rule. Focus rules should fire when the student knows enough to complete the task but not enough to get the task correct.

- If 40%-79% of the targets in the first three journal entries are correct  
And the first three journal entries have been tried

**Then provide focus feedback**

This focus rule also shows scoping. The rules are scoped to fire between 40% and 79%. Below 40% is redirect and above 79% is polish. The rule also fires only  
5 when all of the required work has been attempted.

### **Redirect**

Redirect rules should fire when it is clear that the student does not have a good understanding of how to complete the task. This is evidenced by a significant  
10 number of errors found in the student's work.

**If less than 40% of the first three journal entries are correct**

**And the first three journal entries have been tried.**

**Then provide redirect feedback**  
15

This redirect rule is to catch those who are truly lost. If the student has tried to complete all of the work, and they are less than 40% correct, then they need a great deal of help to continue the task.

### **Mastermind** 20

Mastermind rules need to track down situations when the student is simply trying to cheat his way through the application.

**If less than 40% of the first three journal entries are correct**

**And the student has made only one change twice in a row.**  
25

**Then provide mastermind feedback**

This mastermind rule catches those who are making one change, asking for feedback over and over. One thing to keep in mind is that as a student gets towards praise  
30 they need to make small changes and then ask for feedback. To allow this, the

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above rule is scoped so that if the student has more than 40% of the work right the rule will not fire.

### **Incomplete**

- 5 In many activities the student should try and complete most if not all of the work before asking for feedback. One of the goals of many training applications is to mimic the real world, and it is rare for an employee to ask for a review after every little step they complete. Most employers want to see a significant amount of work done before asking for a review.

10

**If all of journal entries have NOT been tried,  
Then provide incomplete feedback**

- 15 Forcing a student to attempt all of his work first will require him to gain confidence in his ability to complete the work. Therefore, incomplete rules should be used after baby-step feedback so that students feel that they have the tools and ability to complete the whole task before asking for feedback.

### **Principles of Rule Design**

- 20 There are a couple of general rules which make rule creation and maintenance easier.

### **Use percentages whenever possible**

- 25 It may seem easier at the time to write rules which look for specific numbers of right and wrong items. But when a rule is written which looks for a specific number, it means that if the data ever changes, you will need to get back into that rule and tweak it so that it still fires at the right time. It is far better to write percentage rules which fire whenever a certain percentage of work is either right or wrong. Then if the data ever changes and more right answers are added or some removed, then the rules may not need to be rewritten.

30

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### Scope the rules as tightly as possible

As stated previously, it is very important to make the rules mirror the written feedback. If the feedback is vaguer than the rule, then the students will not understand the exact nature of the problem. The feedback will simply hint at it. If the feedback is more specific than the rule, students will become confused. The student may not have made the specific error the feedback is referring to under the umbrella rule.

### Data Dictionary In Accordance With

#### A Preferred Embodiment

#### 10 *Domain Knowledge Model Data Dictionary*

Column	Type	Len	Description
<b>Source</b>			
SourceID	Counter		Unique key for this table
Source	String	50	Name of this object
SourceDesc	String	255	Documentation String that appears with this object in auto-documentation reports
SourceCaption	String	50	String that can be dynamically embedded into feedback text using Parameter Substitution Language (PSL)
<b>SourceItem</b>			
SourceItemID	Counter		Unique key for this table
SourceItem	String	50	Name of this Object
SourceItemDesc	String	255	Documentation String that appears with this object in auto-documentation reports
SourceItemText	String	50	String that Can be dynamically embedded into feedback text

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			using Parameter Substitution Language (PSL)
<b>TargetPage</b>			
TargetPageID	Counter		Unique key for this table
TargetPage	String	50	Name of this object
TargetPageDesc	String	255	Documentation String that appears with this object in auto-documentation reports
TargetPageCaption	String	50	String that Can be dynamically embedded into feedback text using Parameter Substitution Language (PSL)
<b>Target</b>			
TargetID	Counter		Unique key for this table
Target	String	50	Name of this object
TargetDesc	String	255	Documentation String that appears with this object in auto-documentation reports
TargetCaption	String	50	String that Can be dynamically embedded into feedback text using Parameter Substitution Language (PSL)
<b>SourceItemTarget</b>			
SourceItemID	Long		SourceItemID of the association
TargetID	Long		TargetID of the association
Relevance	Float		Value between -1 and 1 that indicates the relative relevance

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			of this association between a SourceItem and a Target. A negative value indicates that this association is incorrect. A positive value indicates that it is correct. A value of zero indicates that this association is irrelevant.
<b>Attribute</b>			
SourceItemID	Long		SourceItemID of the association
TargetID	Long		TargetID of the association
AttributeID	Counter		Unique key for this table
Attribute	String	50	Name of this object
CorrectInd	Bool		Boolean value that indicates whether this Attribute is correct or incorrect for this association of SourceItem and Target
AttributeMin	Double		The lower bound for the range of this attribute.
AttributeMax	Double		The upper bound for the range of this attribute.
<b>ControlSourceItem</b>			
ModuleName	String	50	Name of module the control is on
ControlName	String	50	Name of Control the

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			SourceItem is mapped to
ItemNo	Integer		A single control may be mapped to multiple SourceItems depending on how it is viewed. If one control is used on four different tabs to show four different values, the ItemNo will change as the tabs change, but the ControlName will stay the same.
SourceItemID	Long		ID of SourceItem that this control is mapped to
Start	Integer		For controls that contain text, this is the start position of the text that the SourceItem is associated with.
End	Integer		For controls that contain text, this is the end position of the text that the SourceItem is associated with.
TaskID	Long		This is the TaskID the module is in
Description	Text	255	Comment Information that can appear in the generated documentation reports.
ControlTarget			
ModuleName	String	50	Name of module the control is
ControlName	String	50	Name of Control the SourceItem is mapped to

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ItemNo	Integer		A single control may be mapped to multiple Targets depending on how it is viewed. If one control is used on four different tabs to show four different values, the ItemNo will change as the tabs change, but the ControlName will stay the same.
TargetID	Long		ID of Target that this control is mapped to
Start	Integer		For controls that contain text, this is the start position of the text that the Target is associated with.
End	Integer		For controls that contain text, this is the end position of the text that the Target is associated with.
TaskID	Long		This is the TaskID the module is in
Description	Text	255	Comment Information that can appear in the generated documentation reports.

***Student Data Model Data Dictionary***

**Column            Type    Len    Description**

<b>Student</b>			
SourceID	Counter		Unique key for this table

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Source	String	50	Name of this object
SourceDesc	String	255	Documentation String that appears with this object in auto-documentation reports
SourceCaption	String	50	String that Can be dynamically embedded into feedback text using Parameter Substitution Language (PSL)
StudentSubmissi on			
SourceItemID	Counter		Unique key for this table
SourceItem	String	50	Name of this Object
SourceItemDesc	String	255	Documentation String that appears with this object in auto-documentation reports
SourceItemText	String	50	String that Can be dynamically embedded into feedback text using Parameter Substitution Language (PSL)
UserSourceItemTar get			
SourceItemID	Counter		Unique key for this table
SourceItem	String	50	Name of this Object
SourceItemDesc	String	255	Documentation String that appears with this object in auto-documentation reports
SourceItemText	String	50	String that Can be dynamically embedded into

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			feedback text using Parameter Substitution Language (PSL)

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**Rule Model Data Dictionary**

Column	Type	Len	Description
--------	------	-----	-------------

Rule			
TaskID	Long		ID of Task for which this rule is in scope
CoachID	Long		ID of Coach for which this rule is in scope
RuleID	Counter		Unique key for this table
Rule	String	50	Name of this object
RuleDesc	String	255	Documentation String that appears with this object in auto-documentation reports
RuleCondCountMin	Integer		Minimum number of conditions that must be true for this Rule to fire
RuleCondCountMax	Integer		Maximum number of conditions that must be true for this Rule to fire
CoachTopicID	Long		ID of CoachTopic that is activated when this rule fires
RuleAggregateAnds			
RuleID	Long		ID of Rule of which this object is a condition
RuleCondID	Counter		Unique key for this table
TargetGroupID	Long		ID of TargetGroup whose aggregate values are

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			compared to the aggregate boundaries of this condition.
AggRelevanceMin AggRelevanceMax	Float		The TargetGroup's Calculated Aggregate Relevance must fall between this Min and Max for this condition to be true
AggUserCntPosMin AggUserCntPosMax	Integer		The <u>positive-relevance associations</u> the user has made using Targets in this TargetGroup are counted to produce an Aggregate value called 'UserCntPos'. This TargetGroup's UserCntPos must fall between this condition's AggUserCntPosMin and AggUserCntPosMax for this condition to be true.
AggUserCntNegMin AggUserCntNegMax	Integer		The <u>negative-relevance associations</u> the user has made using Targets in this TargetGroup are counted to produce an Aggregate value called 'UserCntNeg'. This TargetGroup's UserCntNeg must fall between this condition's

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			AggUserCntNegMin and AggUserCntNegMax for this condition to be true.
AggUserCntZeroMin AggUserCntZeroMax	Integer		The <u>zero-relevance associations</u> the user has made using Targets in this TargetGroup are counted to produce an Aggregate value called 'UserCntZero'. This TargetGroup's UserCntZero must fall between this condition's AggUserCntZeroMin and AggUserCntZeroMax for this condition to be true.
AggUserSumPosMin AggUserSumPosMax	Float		The relevance values of the <u>positive-relevance associations</u> the user has made using Targets in this TargetGroup are summed to produce an Aggregate value called 'UserSumPos'. This TargetGroup's UserSumPos must fall between this condition's AggUserSumPosMin and AggUserSumPosMax for this condition to be true.
AggUserSumNegMin	Float		The relevance values of

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AggUserSumNegMax			the <u>negative-relevance associations</u> the user has made using Targets in this TargetGroup are summed to produce an Aggregate value called 'UserSumNeg'. This TargetGroup's UserSumNeg must fall between this condition's AggUserSumNegMin and AggUserSumNegMax for this condition to be true.
AggUserCntPos2Min AggUserCntPos2Max	Integer		The <u>positive-relevance associations</u> the user has made using Targets in this TargetGroup where the user's Attribute are counted to produce an Aggregate value called 'UserCntPos2'. This TargetGroup's UserCntPos2 must fall between this condition's AggUserCntPos2Min and AggUserCntPos2Max for this condition to be true.
<b>RuleSpecificMapping</b> <b>Ands</b>			
RuleID	Long		ID of Rule of which this object is a condition

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SourceItemID	Long		SourceItemID of the association
TargetID	Long		TargetID of the association
SourceItemID	Long		Unique key for this table
AttributeMatchType	Byte		
AttributeID	Long		Documentation String that appears with this object in auto-documentation reports
AttributeMatchType			
AttributeMatchType	Byte		Unique key for this table
AttributeMatchTypeDesc	String	255	Brief text description of each AttributeMatchType Type

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**Feedback Model Data Dictionary**

**Column            Type    Len    Description**

<b>CoachTopic</b>			
TaskID	Long		ID of Task for which this object is in scope
TargetGroupID	Long		ID of TargetGroup which this topic of remediation relates to
CoachTopicID	Counter		Unique key for this table
CoachTopic	String	50	Name of this object
CoachTopicDesc	String	255	Documentation String that appears with this object in auto-documentation reports
CoachTopicPriority	String	3	Priority of this CoachTopic with respect to other CoachTopics in the same TargetGroup
RemediationType	String	50	Type of remediation that this CoachTopic is. This determines how the CoachTopic is handled at runtime.
CoachItemStandAloneReentrySeqID	String	50	When all the Stand Alone CoachItems in this CoachTopic have been used, they are restarted on the CoachItemStandAloneReentry SeqID. If the CoachItemStandAloneReentry SeqID = 0 the StandAlone half of the CoachTopic is

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			expired and no longer used.
CoachItemChildReentrySeqID	String	50	When all the Child CoachItems in this CoachTopic have been used, they are restarted on the CoachItemChildReentrySeqID. If the CoachItemChildReentrySeqID = 0 the Child half of the CoachTopic is expired and no longer used.
<b>RemediationType</b>			
SourceItemID	Counter		Unique key for this table
SourceItem	String	50	Name of this Object
SourceItemDesc	String	255	Documentation String that appears with this object in auto-documentation reports
SourceItemText	String	50	String that Can be dynamically embedded into feedback text using Parameter Substitution Language (PSL)
<b>CoachItem</b>			
SourceItemID	Counter		Unique key for this table
SourceItem	String	50	Name of this Object
SourceItemDesc	String	255	Documentation String that appears with this object in

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			auto-documentation reports
SourceItemText	String	50	String that Can be dynamically embedded into feedback text using Parameter Substitution Language (PSL)

### Source Code In Accordance With A Preferred Embodiment

```
////////////////////////////////////
// tutxport.h
5
////////////////////////////////////
// Control Functions
/*
*****
10 * Name:      TuResumeStudent
   * Purpose:   To Resume a Student In progress.
   * Author:    Mike Smialek / Andersen Consulting
   * Input
   * Parameters: long StudentID
15 *           The Unique ID of the Student to load
   *
   *           long TaskID
   *           The Unique ID of the Task to Load
   *
20 *           int fromSubmissionSeqID
   *           The Submission from which the Student continues the Task
   *           <0 :Resume Task from latest submission
   *           =0 :Restart Task
   *           >0 :Continue from a specific submission
25 *
```

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\* Output

\* Parameters: none

\* Function Return

\* Variables: TUT\_ERR\_DB\_COULDNT\_OPEN\_DATABASE

5 \* TUT\_ERR\_DOC\_COULDNT\_LOAD\_TASK\_DOC  
\* TUT\_ERR\_LOD\_NO\_COACHTOPICS\_FOUND  
\* TUT\_ERR\_LOD\_NO\_COACHITEMS\_FOUND  
\* TUT\_ERR\_LOD\_NO\_COACHES\_FOUND  
\* TUT\_ERR\_LOD\_NO\_SOURCEITEMTARGETS\_FOUND  
10 \* TUT\_ERR\_LOD\_NO\_SOURCES\_FOUND  
\* TUT\_ERR\_LOD\_NO\_SOURCEITEMS\_FOUND  
\* TUT\_ERR\_LOD\_NO\_TARGETGROUPS\_FOUND  
\* TUT\_ERR\_LOD\_NO\_TARGETS\_FOUND  
\* TUT\_ERR\_LOD\_NO\_TARGETPAGES\_FOUND  
15 \* TUT\_ERR\_LOD\_NO\_TARGETGROUPTARGETS\_FOUND  
\* TUT\_ERR\_LOD\_NO\_RULES\_FOUND  
\* TUT\_ERR\_DB\_COULDNT\_OPEN\_RECORDSET  
\*  
\* TUT\_ERR\_OK

20

\* Notes: Loads from Database or Document based on values  
\* of m\_StorageTypeTask and m\_StorageTypeStudent  
\*

\*\*\*\*\*

25 \*/

extern "C"

{

long \_\_export WINAPI TuResumeStudent(long StudentID, long TaskID, int  
fromSubmissionSeqID ); // Resumes a Student's work for the Task at the specified

30 Submission

}

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{

```
5 TaskID, int fromSubmissionSeqID, int toSubmissionSeqID); // Loads Archived
Submissions For a Student's work in a Task
```

}

{

```

10 {
    long __export WINAPI TuUseArchivedSubmissions(int n); // Replays n
    Archived submissions for debugging

```

}

```
15 extern "C"
```

{

```
long __export WINAPI TuSaveCurrentStudent(); // Saves Current Student's
work to DB
```

}

20

 $\{$ 

```
long __export WINAPI TuSimulateStudent(long StudentID, long TaskID, float
Intelligence, float Tenacity, int MaxTurns); // Not operational
```

}

extern "C"

}

```

    long __export WINAPI TuWriteUserDebugInfo(); // writes active CoachTopics
30  to DB for Debugging

```

)

extern "C"

{

5 long \_\_export WINAPI KillEngine( long lTaskID); // Delete all Dynamic  
objects before shutdown  
}

/\*

\*\*\*\*\*

10 \* Name: LoadTaskInfo  
\* Purpose: To load data for a Task only. Student data is not loaded  
\* Author: Mike Smialek / Andersen Consulting  
\* Input  
\* Parameters: long TaskID  
15 \* The Unique ID of the Task to Load  
\* Output  
\* Parameters: none  
\*  
\* Function Return  
20 \* Variables: TUT\_ERR\_DB\_COULDNT\_OPEN\_DATABASE  
\* TUT\_ERR\_DOC\_COULDNT\_LOAD\_TASK\_DOC  
\* TUT\_ERR\_LOD\_NO\_COACHTOPICS\_FOUND  
\* TUT\_ERR\_LOD\_NO\_COACHITEMS\_FOUND  
\* TUT\_ERR\_LOD\_NO\_COACHES\_FOUND  
25 \* TUT\_ERR\_LOD\_NO\_SOURCEITEMTARGETS\_FOUND  
\* TUT\_ERR\_LOD\_NO\_SOURCES\_FOUND  
\* TUT\_ERR\_LOD\_NO\_SOURCEITEMS\_FOUND  
\* TUT\_ERR\_LOD\_NO\_TARGETGROUPS\_FOUND  
\* TUT\_ERR\_LOD\_NO\_TARGETS\_FOUND  
30 \* TUT\_ERR\_LOD\_NO\_TARGETPAGES\_FOUND  
\* TUT\_ERR\_LOD\_NO\_TARGETGROUPTARGETS\_FOUND

"TUT\_ERR\_LOD\_NO\_TARGETGROUPTARGETS\_FOUND"

```

*          TUT_ERR_LOD_NO_RULES_FOUND
*          TUT_ERR_DB_COULDNT_OPEN_RECORDSET
*
*          TUT_ERR_OK
5  * Notes:
*****
*/
extern "C"
{
10    long __export WINAPI LoadTaskInfo( long lTaskID ); // Clear and (re)load info
    for TaskID
}

/*
15 *****
*
* Name:          TuLoadTaskDoc
* Purpose:       Loads a Tutor Document containing Task Data
* Author:        Mike Smialek / Andersen Consulting
20 * Input
* Parameters:    long lTaskID
*               TaskID To Load
* Output
* Parameters:    none
25 *
* Function Return
* Variables:     TUT_ERR_DOC_COULDNT_LOAD_TASK_DOC
*               TUT_ERR_LOD_NO_COACHTOPICS_FOUND
*               TUT_ERR_LOD_NO_COACHITEMS_FOUND
30 *               TUT_ERR_LOD_NO_COACHES_FOUND
*               TUT_ERR_LOD_NO_SOURCEITEMTARGETS_FOUND

```

```

*          TUT_ERR_LOD_NO_SOURCES_FOUND
*          TUT_ERR_LOD_NO_SOURCEITEMS_FOUND
*          TUT_ERR_LOD_NO_TARGETGROUPS_FOUND
*          TUT_ERR_LOD_NO_TARGETS_FOUND
5  *          TUT_ERR_LOD_NO_TARGETPAGES_FOUND
*          TUT_ERR_LOD_NO_TARGETGROUPTARGETS_FOUND
*          TUT_ERR_LOD_NO_RULES_FOUND
*
*          TUT_ERR_OK
10 *
* Notes:      TaskID is used to format the file name of the Document.
*
*****
*/
15 extern "C"
{
    long __export WINAPI TuLoadTaskDoc( long lTaskID ); // Clear and (re)load
info for TaskID from TaskDoc
}
20
/*
*****
* Name:      TuSaveTaskDoc
* Purpose:    Saves The Task data as a Tutor Document
25 * Input
* Parameters: long lTaskID
*            TaskID To Save
* Output
* Parameters: none
30 *
* Function Return

```

```
* Variables:      TUT_ERR_DOC_COULDNT_SAVE_TASK_DOC
*
*                TUT_ERR_OK
*
5  * Notes:        TaskID is currently only used to format the file name of the
Document.
*                If a TaskID is passed in that is different than the loaded Task,
*                it will save the loaded data as if it were data for Task ID
*****
10 */
extern "C"
{
    long __export WINAPI TuSaveTaskDoc( long lTaskID ); // Save info for
TaskID into TaskDoc
15 }

/*
*****

* Name:          TuGo
20 * Purpose:      Kicks off Submission or Secret Submission
* Input
* Parameters:     long lCoachID
*                CoachID submitting to
*                >0 :Submit to Specific Coach
25 *                =0 :Secret Submission to all Coaches
* Output
* Parameters:     none
*
* Function Return
30 * Variables:    TUT_ERR_OK
*
```

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\*\*\*\*\*

```
extern "C"
```

```

/*
10 *****
* Name:          TuIsDirty
* Purpose:       Gets the Dirty Status of the Task or of an individual Coach
* Input
* Parameters:    long lCoachID
15 *              CoachID for which to determine Dirty Status
*              >0 :Determines Dirty Status for specific Coach
*              =0 :Determines Dirty Status for whole Task
* Output
* Parameters:    LPINT IsDirty
20 *              TRUE indicates this Coach or Task is Dirty
*              FALSE indicates this Coach or Task is not Dirty
*              If one or more Coaches is dirty the Task is Dirty
* Function Return
* Variables:     TUT_ERR_LOD_NO_COACHES_FOUND
25 *              TUT_ERR_LOD_COACHID_NOT_FOUND
*              TUT_ERR_OK

```

\*\*\*\*\*1\*\*\*\*\*

```
30 extern "C"
    {
```

```
long __export WINAPI TuIsDirty(long TaskID, long lCoachID, LPINT IsDirty);
```

```
}
```

```
/*
```

```
5 *****
```

```
* Name:          TuGetSubmissionSeqID
```

```
* Purpose:       Returns the current SubmissionSeqID
```

```
* Author:        Mike Smialek / Andersen Consulting
```

```
* Input
```

```
10 * Parameters:   long TaskID
```

```
*               The TaskID for which you want the SubmissionSeqID
```

```
* Output
```

```
* Parameters:    none
```

```
*
```

```
15 * Function Return
```

```
* Variables:     SubmisisonSeqID of the current Submission
```

```
*
```

```
* Notes:
```

```
*****
```

```
20 */
```

```
extern "C"
```

```
{
```

```
    long __export WINAPI TuGetSubmissionSeqID(long TaskID);
```

```
}
```

```
25
```

```
/*
```

```
*****
```

```
* Name:          TuGetFeedbackPrevCoachID
```

```
* Purpose:       Returns the CoachID of The Coach That delivered the previous
```

```
30 feedback
```

```
* Function Return
```

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\* Variables: CoachID of The Coach That delivered the previous feedback

\* Notes:

\*\*\*\*\*

\*/

5 extern "C"

{

long \_\_export WINAPI TuGetFeedbackPrevCoachID();

}

10 /\*

\*\*\*\*\*

\* Name: TuGetApprovalStatus

\* Purpose: Gets the Approval Status of the Task or of an individual Coach

\* Input

15 \* Parameters: long lCoachID

\* CoachID for which to determine Approval

\* >0 :Determines approval for specific Coach

\* =0 :Determines approval for whole Task

\* Output

20 \* Parameters: LPINT ApprovalRequired

\* TRUE indicates this Coach or Task requires approval

\* FALSE indicates this Coach or Task does not require approval

\* (Always TRUE when input CoachID = 0)

\*

25 \* LPINT Approved

\* TRUE indicates this Coach or Task is approved

\* FALSE indicates this Coach or Task is not approved

\*

\* Function Return

30 \* Variables: TUT\_ERR\_LOD\_NO\_COACHES\_FOUND

\* TUT\_ERR\_LOD\_COACHID\_NOT\_FOUND

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30

```
{
    long __export WINAPI TuCanProceed( long lTaskID, LPINT CanProceed );
}
/*
5  *****
   * Name:          TuMenu
   * Purpose:       Opens Menu Dialog
   * Author:        Mike Smialek / Andersen Consulting
   * Input
10  * Parameters:    none
   * Output
   * Parameters:    none
   * Function Return
   * Variables:     TUT_ERR_OK
15  * Notes:
   *****
   */
   extern "C"
   {
20  long __export WINAPI TuMenu();
   }

   /*
   *****
25  * Name:          TuTesterComment
   * Purpose:       Opens Tester Comment Dialog
   * Input
   * Parameters:     none
   * Output
30  * Parameters:     none
   * Function Return
```

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### \* Function Return

```
* Variables:      TUT_ERR_TUF_USIT_TARGET_NOT_FOUND
*
*                  TUT_ERR_TUF_USIT_DUPLICATE_FOUND
*
*                  TUT_ERR_OK
5  * Notes:
*****
*/
extern "C"
{
10  long  __export WINAPI TuCreateMap( long SIID, long TID, double Attr );
}

/*
*****
15  * Name:          TuModifyMap
* Purpose:         To Modify an association between a SourceItem and a Target
*                  with a new modifying Attribute value
* Input
* Parameters:      long SIID
20  *
*                  SourceItemID of existing association to Modify
*
*                  long TID
*
*                  TargetID of existing association to Modify
*
*                  double Attr
*
*                  New Attribute value for association
25  * Output
* Parameters:      none
* Function Return
* Variables:      TUT_ERR_TUF_USIT_TARGET_NOT_FOUND
*
*                  TUT_ERR_TUF_USIT_DUPLICATE_FOUND
30  *
*
*                  TUT_ERR_OK
```

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```

*
* Notes:      This function calls TuDeleteMap / TuCreateMap
*
*****
5  */
extern "C"
{
    long __export WINAPI TuModifyMap( long SIID, long TID, double Attr );
}
10
/*
*****
* Name:      TuDeleteMap2
* Purpose:    To Delete an association between a SourceItem and a Target
15 * Input
* Parameters: long SIID
*              SourceItemID of association to delete
*
*              long TID
20 *              TargetID of association to delete
*
*              double Attr
*              Attribute value of association to delete
* Output
25 * Parameters: none
* Function Return
* Variables:  TUT_ERR_TUF_USIT_TARGET_NOT_FOUND
*              TUT_ERR_TUF_USIT_NOT_FOUND
*
30 *              TUT_ERR_OK
*

```

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```
* Notes:      This function ignores the Attribute value and calls
*              TuDeleteMap( long SIID, long TID )
*****
*/
5  extern "C"
{
    long  __export WINAPI TuDeleteMap2( long SIID, long TID, double Attr );
}

10 /*
*****
* Name:      TuDeleteMap
* Purpose:   To Delete and association between a SourceItem and a Target
* Input
15 * Parameters:   long SIID
*                  SourceItemID of association to delete
*
*                  long TID
*                  TargetID of association to delete
20 *
* Output
* Parameters:   none
*
* Function Return
25 * Variables:   TUT_ERR_TUF_USIT_TARGET_NOT_FOUND
*                TUT_ERR_TUF_USIT_NOT_FOUND
*                TUT_ERR_OK
* Notes:
*****
30 */
extern "C"
```

T02230"4264E60

```
{
    long __export WINAPI TuDeleteMap( long SIID, long TID );
}
```

```
5  //////////////////////////////////////
   //////////////////////////////////////
```

```
// Configuration Functions
```

```
/*
```

```
*****
```

```
10 * Name:          TuSetODBCConnect
   * Purpose:       To set ODBC Connect String for the Task Data Database
   * Input
   * Parameters:    LPCSTR ODBCConnect
   *                ODBC Connect String for the Task Data Database
```

```
15 * Output
   * Parameters:    none
   *
   * Function Return
   * Variables:     TUT_ERR_OK
```

```
20 *
   * Notes:
   *****
   */
```

```
extern "C"
```

```
25 {
    long __export WINAPI TuSetODBCConnect( LPCSTR ODBCConnect );
}
```

```
/*
```

```
30 *****
```

```
* Name:          TuSetODBCConnectTrack
```

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\* Purpose: To set ODBC Connect String for the Student Tracking Database

\* Input

\* Parameters: LPCSTR ODBCCConnect

\* ODBC Connect String for the Student Tracking Database

5 \* Output

\* Parameters: none

\* Function Return

\* Variables: TUT\_ERR\_OK

\* Notes:

10 \*\*\*\*\*

\*/

extern "C"

{

long \_\_export WINAPI TuSetODBCConnectTrack( LPCSTR ODBCCConnect );

15 }

/\*

\*\*\*\*\*

\* Name: TuSetTaskDocPathName

20 \* Purpose: To set path and name of the Task Document file

\* Input

\* Parameters: LPCSTR fnm

\* Path and name of the Task Document file

\* Output

25 \* Parameters: none

\*

\* Function Return

\* Variables: TUT\_ERR\_OK

\*

30 \* Notes:

\*\*\*\*\*

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```
*/
extern "C"
{
    long __export WINAPI TuSetTaskDocPathName( LPCSTR fnm );
5 }
/*
*****

* Name:          TuSetFeedbackFileName
* Purpose:       To set path and name of file to use for holding feedback
10 * Input
* Parameters:    LPCSTR fnm
*               Path and name of file to use for holding feedback
* Output
* Parameters:    none
15 *
* Function Return
* Variables:     TUT_ERR_OK
*
* Notes:
20 *****

*/
extern "C"
{
    long __export WINAPI TuSetFeedbackFileName( LPCSTR fnm );
25 }

/*
*****

* Name:          TuSetFeedbackPrevFileName
30 * Purpose:     To set path and name of file to use for holding previous feedback
* Input
```

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```

* Parameters:      LPCSTR fnm
*
* Path and name of file to use for holding previous feedback
* Output
* Parameters:      none
5  *
* Function Return
* Variables:       TUT_ERR_OK
* Notes:
*****
10 */
extern "C"
{
    long __export WINAPI TuSetFeedbackPrevFileName( LPCSTR fnm );
/*
15 *****
* Name:           TuSetLogFileName
* Purpose:        To set path and name of file to use for full logging
* Input
* Parameters:     LPCSTR fnm
20 * Path and name of file to use for full logging
* Output
* Parameters:     none
*
* Function Return
25 * Variables:     TUT_ERR_OK
* Notes:
*****
*/
extern "C"
30 {
    long __export WINAPI TuSetLogFileName( LPCSTR fnm );

```

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```

}
/*
*****

* Name:          TuSetLogLoadFileName
5  * Purpose:      To set path and name of file to use for load logging
* Input
* Parameters:     LPCSTR fnm
*                  Path and name of file to use for load logging
* Output
10 * Parameters:    none
*
* Function Return
* Variables:      TUT_ERR_OK
*
15 * Notes:
*****

*/
extern "C"
{
20   long  __export WINAPI TuSetLogLoadFileName( LPCSTR fnm );
}

/*
*****

25 * Name:          TuSetLogStudentFileName
* Purpose:        To set path and name of file to use for student logging
* Input
* Parameters:     LPCSTR fnm
*                  Path and name of file to use for student logging
30 * Output
* Parameters:     none

```

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```
*
* Function Return
* Variables:      TUT_ERR_OK
*
5  * Notes:
    *****
    */
    extern "C"
    {
10     long  __export WINAPI TuSetLogStudentFileName( LPCSTR fnm );
    }

    /*
    *****
15  * Name:          TuSetLogSubmissionFileName
    * Purpose:       To set path and name of file to use for submission logging
    * Input
    * Parameters:    LPCSTR fnm
    *               Path and name of file to use for submission logging
20  * Output
    * Parameters:    none
    *
    * Function Return
    * Variables:     TUT_ERR_OK
25  *
    * Notes:
    *****
    */
    extern "C"
30  {
    long  __export WINAPI TuSetLogSubmissionFileName( LPCSTR fnm );
```

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}

/\*

\*\*\*\*\*

5 \* Name: TuSetLogErrFileName  
 \* Purpose: To set path and name of file to use for error logging

\* Input

\* Parameters: LPCSTR fnm

\* Path and name of file to use for error logging

10 \* Output

\* Parameters: none

\*

\* Function Return

\* Variables: TUT\_ERR\_OK

15 \* Notes:

\*\*\*\*\*

\*/

extern "C"

{

20 long \_\_export WINAPI TuSetLogErrFileName( LPCSTR fnm );

}

/\*

\*\*\*\*\*

25 \* Name: TuSetTrace

\* Purpose: To turn Trace on and off

\* Input

\* Parameters: int TraceStatus

\* TUT\_TRACE\_ON :Turn Trace On

30 \* TUT\_TRACE\_OFF :Turn Trace Off

\* Output

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```

* Parameters:      none
*
* Function Return
* Variables:      Previous Trace Status Value
5  *              TUT_TRACE_ON
    *              TUT_TRACE_OFF
    *
    *              TUT_ERR_INVALID_TRACE_STATUS
* Notes:
10 *****
   */
   extern "C"
   {
       long __export WINAPI TuSetTrace( int TraceStatus );
15  }
   /*
   *****

* Name:           TuSetTrack
* Purpose:        To turn Tracking on and off. While tracking is on
20  *              all work the user does and all feedback the user receives
    *              is kept. While Tracking is off only the most recent work is kept.
* Input
* Parameters:      int TrackStatus
    *              TUT_TRACK_ON :Turn Tracking On
25  *              TUT_TRACK_OFF :Turn Tracking Off
* Output
* Parameters:      none
* Function Return
* Variables:      Previous Trace Status Value
30  *              TUT_TRACK_ON
    *              TUT_TRACK_OFF

```

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```

*
*          TUT_ERR_INVALID_TRACK_STATUS
* Notes:
*****
5  */
   extern "C"
   {
       long __export WINAPI TuSetTrack( int TrackStatus );
   }
10
   /*
   *****
   * Name:          TuSetShowExceptionPopup
   * Purpose:       To Exception popups on and off.
15  * Input
   * Parameters:    int PopupStatus
   *
   *          TUT_POPUP_ON :Turn Exception popups On
   *          TUT_POPUP_OFF :Turn Exception popups Off
   * Output
20  * Parameters:    none
   *
   * Function Return
   * Variables:     Previous Exception popup Status Value
   *
   *          TUT_POPUP_ON
25  *          TUT_POPUP_OFF
   *
   *          TUT_ERR_INVALID_POPUP_STATUS
   * Notes:
   *****
30  */
   extern "C"

```

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```
{
    long __export WINAPI TuSetShowExceptionPopup( int PopupStatus );
}
```

5 /\*

\*\*\*\*\*

\* Name: TuSetStorageType

\* Purpose: To Direct Task and Student data to be loaded and saved  
\* using a Document or Database

10 \* Input

\* Parameters: long StorageTypeTask

\* TUT\_STORAGE\_TYPE\_DOCUMENT :Load and Save Task  
Data using Document

\* TUT\_STORAGE\_TYPE\_DATABASE :Load and Save Task Data

15 using Database

\*

\* long StorageTypeStudent

\* TUT\_STORAGE\_TYPE\_DOCUMENT :Load and Save Student  
Data using Document

20 \* TUT\_STORAGE\_TYPE\_DATABASE :Load and Save Student  
Data using Database

\* Output

\* Parameters: none

\*

25 \* Function Return

\* Variables: TUT\_ERR\_INVALID\_STORAGE\_TYPE\_TASK

\* TUT\_ERR\_INVALID\_STORAGE\_TYPE\_STUDENT

\*

\* TUT\_ERR\_OK

30 \* Notes:

\*\*\*\*\*

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```
*/
extern "C"
{
    long __export WINAPI TuSetStorageType( int StorageTypeTask, int
5 StorageTypeStudent );
}
////////////////////////////////////
////////////////////////////////////
```

### Simulation Engine

The idea is for the designer to model the task that he wants a student to accomplish using an Excel spreadsheet. Then, have an algorithm or engine that reads all the significant cells of the spreadsheet and notifies the Intelligent Coaching Agent with the appropriate information (SourceItemID, TargetID and Attribute). This way, the spreadsheet acts as a central repository for student data, contains most of the calculations required for the task and in conjunction with the engine handles all the communication with the ICA. The task is self contained in the spreadsheet, therefore the designers no longer need a graphical user interface to functionally test their designs (smart spreadsheet). Figure 40 is a block diagram illustrating how the simulation engine is architected into a preferred embodiment of the invention.

Once the model and feedback for it are completely tested by designers, developers can incorporate the spreadsheet in a graphical user interface, e.g., Visual Basic as a development platform. The simulation spreadsheet is usually invisible and populated using functions provided by the engine. It is very important that all modifications that the ICA needs to know about go through the engine because only the engine knows how to call the ICA. This significantly reduced the skill level required from programmers, and greatly reduced the time required to program each task. In addition, the end-product was less prone to bugs, because the tutor management was centralized. If there was a tutor problem, we only had to check on section of code. Finally, since the simulation engine loaded the data from a

spreadsheet, the chance of data inconsistency between the tutor and the application was nil.

## 5 Object Model

Figure 41 is a block diagram setting forth the architecture of a simulation model in accordance with a preferred embodiment. The Simulation Object Model consists of a spreadsheet model, a spreadsheet control object, a simulation engine object, a simulation database, input objects, output objects, list objects and path objects.

10

### *Spreadsheet object*

The first object in our discussion is the Spreadsheet object. The Spreadsheet is the support for all simulation models. A **control** object that is readily integrated with the Visual Basic development plat. The control supports printing and is compatible with Microsoft Excel spreadsheets. With that in mind, designers can use the power of Excel formulas to build the simulation. The different cells contained in the spreadsheet model can be configured as Inputs, Outputs or Lists and belong to a simulation Path.

15

### *Input object*

All cells in the spreadsheet that need to be manually entered by the designer or the student via the GBS application are represented by input objects. Every input has the following interface:

20

Field Name	Data Type	Description
InputID	long	Primary Key for the table
TaskID	long	TaskID of the task associated with the input
PathID	long	PathID of the path associated with the input
InputName	string*50	Name of the input
InputDesc	string*255	Description of the input
ReferenceName	string*50	Name of the spreadsheet cell associated

		with the input
TutorAware	boolean	Whether the ICA should be notified of any changes to the input
SourceItemID	long	SourceItemID if input is a distinct input 0 if input is a drag drop input
TargetID	long	TargetID of the input
Row	long	Spreadsheet row number of the input → speed optimization
Column	long	Spreadsheet column number of the input → speed optimization
SheetName	string*50	Sheet name where the input is located → speed optimization

This information is stored for every input in the Input table of the simulation database (ICASim.mdb). Refer to the example below.

- 5 When designers construct their simulation model, they must be aware of the fact that there are 2 types of Inputs:
  1. Distinct Input
  2. Drag & Drop Input

#### 10 Distinct Input

The Distinct Input consists of a single spreadsheet cell that can be filled by the designer at design time or by the GBS application at run time via the simulation engine object's methods. The purpose of the cell is to provide an entry point to the simulation model. This entry point can be for example an answer to a question or a parameter to an equation. If the cell is TutorAware (all inputs are usually TutorAware), the ICA will be notified of any changes to the cell. When the ICA is notified of a change two messages are in fact sent to the ICA:

1. An ICANotifyDestroy message with the input information i.e., SourceItemID, TargetID and null as Attribute. This message is to advise the ICA to remove this information from its memory.
2. An ICANotifyCreate message with the input information i.e., SourceItemID, TargetID, Attribute (cell numeric value) . This message is to advise the ICA to add this information to its memory.

A Distinct Input never requires that a user answer a mathematics question. These are the steps required to configure that simulation. Figure 42 illustrates the arithmetic steps in accordance with a preferred embodiment.

1. Define a name for cell C2 in Excel. Here we have defined "Distinct\_Input".
2. In the ICA, define a task that will be assigned to the simulation. Ex: a TaskID of 123 is generated by the ICA.
3. In the ICA, define a Target for the input. Ex: a TargetID of 4001 is generated by the ICA.
4. In the ICA, define a SourceItem for the input. Ex: a SourceItemID of 1201 is generated by the ICA.
5. Associate the input to a path (refer to Path object discussion).
6. Add the information in the Input table of the simulation engine database.

A record in an Input table is presented below.

InputID:	12345
TaskID:	123
PathID:	1234
InputName:	Question 1 input
InputDesc:	Distinct input for Question 1
ReferenceName:	Distinct_Input
TutorAware:	True
SourceItemID	1201
TargetID:	4001

Row:	2
Column:	3
SheetName:	Sheet1

The Row, Column and SheetName are filled in once the user clicks “Run Inputs/Outputs”. The simulation engine decodes the defined name (Reference Name) that the designer entered, and populates the table accordingly. This is an important step. We had several occasions when a designer would change the layout of a spreadsheet, i.e., move a defined name location, then forget to perform this step. As such, bizarre data was being passed to the tutor; whatever data happened to reside in the old row and column. Once the configuration is completed, the designer can now utilize the ICA Utilities to test the simulation.

### Drag & Drop Input

The drag & drop input consist of two consecutive spreadsheet cells. Both of them have to be filled by the designer at design time or by the GBS application at run time via the simulation engine object’s methods. This type of input is used usually when the user must choose one answer among a selection of possible answers. Drag & drop inputs are always TutorAware. The left most cell contains the SourceItemID of the answer picked by the user (every possible answer needs a SourceItemID) and the rightmost cell can contain a numeric value associated to that answer. You need to define a name or ReferenceName in the spreadsheet for the rightmost cell.

ICA will be notified of any changes to either one of the cells. When the ICA is notified of a change two messages are in fact sent to the ICA:

1. An ICANotifyDestroy message with the input information i.e., SourceItemID before the change occurred, TargetID of the input and the Attribute value before the change occurred.
2. An ICANotifyCreate message with the input information i.e., SourceItemID after the change occurred, TargetID of the input and the Attribute value after the change occurred.

Let's demonstrate the use of a drag & drop input building on top of the previous example. Here, the user is asked to answer yet another mathematics question. These are the steps required to configure that section of the simulation. Figure 43

- 5 illustrates a drag & drop input operation in accordance with a preferred embodiment.
1. Define a name for cell C11 in Excel. Here we have defined "DragDrop\_Input".
  2. Let's use the same TaskID as before since Question 2 is part of the same simulation as Question 1. Ex: TaskID is 123.
  3. In the ICA, define a Target for the input. Ex: a TargetID of 4002 is generated by the ICA.
  - 10 4. In the ICA, define a SourceItem for every possible answer to the question. Ex: SourceItemIDs 1202 to 1205 are generated by the ICA.
  5. Associate the input to a path (refer to Path object discussion).
  6. Add the information in the Input table of the simulation engine database.
- 15 A record in the Input table in accordance with a preferred embodiment is presented below.

InputID:	12346
TaskID:	123
PathID:	1234
InputName:	Question 2 input
InputDesc:	Drag & Drop input for Question 2
ReferenceName:	DragDrop_Input
TutorAware:	True
SourceItemID	0 ***
TargetID:	4002
Row:	11
Column:	3
SheetName:	Sheet1

### *List object*

- Figure 44 illustrates list object processing in accordance with a preferred embodiment. The list object consists of one cell identifying the list (cell #1) and a series of placeholder rows resembling drag & drop inputs (cells #1.1 - 1.n to cells #n.1- n.n). The list is used usually when the user must choose multiple elements among a selection of possible answers. Cell #1 must have a uniquely defined name also called the list name. Cells #1.1 to #n.1 can contain the SourceItemID of one possible answer picked by the user (every possible answer needs a SourceItemID). The content of these cells must follow this format : ~ListName~SourceItemID. Cells #1.2 to #n.2 will hold the numeric value (attribute) associated with the SourceItemID in the cell immediately to the left. Cells #1.3 - 1.n to #n.3 - n.n are optional placeholders for data associated with the answer. KEY NOTE: When implementing a list object the designer must leave all the cells under #n.1 to #n.n blank because this range will shift up every time an item is removed from the list.

Every list has the following interface:

Field Name	Data Type	Description
ListID	long	Primary Key for the table
TaskID	long	TaskID of the task associated with the list
PathID	long	PathID of the path associated with the list
ListName	string*50	Name of the list
ListDesc	string*255	Description of the list
ReferenceName	string*50	Name of the spreadsheet cell associated with the list
TutorAware	boolean	Whether the ICA should be notified of any changes to the list
TargetID	long	TargetID of the output
TotalColumns	long	Total number of data columns

Row	long	Spreadsheet row number of the output → speed optimization
Column	long	Spreadsheet column number of the output → speed optimization
SheetName	string*50	Sheet name were the input is located → speed optimization

Use of a list is demonstrated by continuing our math test. The math question in this example invites the user to select multiple elements to construct the answer. These are the steps required to configure that section of the simulation. Figure 45

- 5 illustrates the steps for configuring a simulation in accordance with a preferred embodiment.
1. Define a name for cell C23 in Excel. Here we have defined “The\_List”.
2. Let’s use the same TaskID as before since Question 3 is part of the same simulation as Question 1 and 2. Ex: TaskID is 123.
- 10 3. In the ICA, define a Target for the list. Ex: a TargetID of 4006 is generated by the ICA.
4. In the ICA, define a SourceItem for every item that could be placed in the list. Ex: the following SourceItemIDs 1209, 1210, 1211, 1212, 1213, 1214 are generated by the ICA.
- 15 5. Associate the list to a path (refer to Path object discussion).
6. Add the information in the List table of the simulation engine database.

A record in the List table in accordance with a preferred embodiment is presented in the table appearing below.

ListID:	12346
TaskID:	123
PathID:	1234
ListName:	Question 3 list
ListDesc:	List for Question 3
ReferenceName:	The_List

TutorAware:	True
TargetID:	4006
TotalColumns:	1
Row:	23
Column:	3
SheetName:	Sheet1

### *Output object*

All cells in the spreadsheet that are result of calculations (do not require any external input) can be represented by output objects. Every output has an interface as

5 outlined in the table below.

Field Name	Data Type	Description
OutputID	long	Primary Key for the table
TaskID	long	TaskID of the task associated with the output
PathID	long	PathID of the path associated with the output
OutputName	string*50	Name of the output
OutputDesc	string*255	Description of the output
ReferenceName	string*50	Name of the spreadsheet cell associated with the output
TutorAware	boolean	Whether the ICA should be notified of any changes to the output
SourceItemID	long	SourceItemID of the output
TargetID	long	TargetID of the output
Row	long	Spreadsheet row number of the output → speed optimization
Column	long	Spreadsheet column number of the output → speed optimization
SheetName	string*50	Sheet name where the input is located → speed optimization

All this information is stored for every output in the Output table of the simulation database (ICASim.mdb). When designers construct their simulation model, they must be aware of the fact that there is only 1 type of Outputs : the Distinct Output.

## 5     **Distinct Output**

A Distinct Output consists of one and only one spreadsheet cell that contains a formula or a result of calculations. The existence of Output cells is the main reason to have a simulation model. If the cell is TutorAware, the ICA will be notified of any changes to the cell when all outputs are processed otherwise the ICA will be unaware of any changes. When the ICA is notified of a change two messages are in fact sent to the ICA:

1. An ICANotifyDestroy message with the output information i.e., SourceItemID, TargetID and null as Attribute. This message is to advise the ICA to remove this information from its memory.
- 15     2. An ICANotifyCreate message with the output information i.e., SourceItemID, TargetID, Attribute (cell numeric value) . This message is to advise the ICA to add this information to its memory. As opposed to Distinct Inputs and Drag & Drop Inputs which notify the ICA on every change, Distinct Outputs are processed in batch just before asking the ICA for feedback .

20

To notify the ICA of the total dollar amount of the items in the list. We definitely need a Distinct Output for that. The output will contain a sum formula. Figure 46 illustrates a distinct output in accordance with a preferred embodiment. The steps required to configure that section of the simulation taking in consideration that the list is already configured are presented below.

25

1. Define a name for cell C24 in Excel. Here we have defined "Distinct\_Output".
2. Let's use the same TaskID as before since Question 3 is part of the same simulation as Question 1 and 2. Ex: TaskID is 123.
3. In the ICA, define a Target for the output. Ex: a TargetID of 4005 is generated
- 30     by the ICA.

4. In the ICA, define a SourceItem for the output. Ex: a SourceItemID of 1215 is generated by the ICA.
  5. Associate the output to a path (refer to Path object discussion).
  6. Add the information in the Output table of the simulation engine database.
- 5 A record in an Output table in accordance with a preferred embodiment is presented below.

OutputID:	12347
TaskID:	123
PathID:	1234
OutputName:	Question 3 output
OutputDesc:	Distinct Output for Question 3
ReferenceName:	Distinct_Output
TutorAware:	True
SourceItemID	1215
TargetID:	4005
Row:	24
Column:	6
SheetName:	Sheet1

### ***Path object***

- Paths are used to divide a simulation model into sub-Simulations meaning that you can group certain inputs, outputs and lists together to form a coherent subset or path.
- 10 Every path has the following interface:

Field Name	Data Type	Description
PathID	long	Primary Key for the table
TaskID	long	TaskID of the task associated with the path
PathNo	long	Numeric value associated to a path
PathName	string*50	Name of the path
PathDesc	string*255	Description of the path

All this information is stored for every path in the path table of the simulation database (ICASim.mdb).

### Simulation Engine

- 5 The simulation engine is the interface between the model, the simulation database and the Intelligent Coaching Agent. The simulation engine is of interest to the designer so that he can understand the mechanics of it all. But it is the developer of applications using the engine that should know the details of the interface (methods & properties) exposed by the engine and the associated algorithms.

10

Once the designer has constructed the simulation model (Excel Spreadsheet) and configured all the inputs, outputs & lists, he is ready to test using the test bench included in the ICA Utilities (refer to ICA Utilities documentation). The developer, in turn, needs to implement the calls to the simulation engine in the GBS application

- 15 he's building. The following list identifies the files that need to be included in the Visual Basic project to use the simulation workbench :

wSimEng.cls	Simulation Engine class
wSimEng.bas	Simulation Engine module (this module was introduced only for speed purposes because all the code should theoretically be encapsulated in the class)
wConst.bas	Intelligent Coaching Agent constant declaration
wDeclare.bas	Intelligent Coaching Agent DLL interface
wIca.cls	Intelligent Coaching Agent class
wIca.bas	Intelligent Coaching Agent module (this module was introduced only for speed purposes because all the code should theoretically be encapsulated in the class)

- 20 To have a working simulation, a developer places code in different strategic areas or stages of the application. There's the Initial stage that occurs when the form containing the simulation front-end loads. This is when the simulation model is

initialized. There's the Modification stages that take place when the user makes changes to the front-end that impacts the simulation model. This is when the ICA is notified of what's happening. There's the Feedback stage when the user requests information on the work done so far. This is when the simulation notifies the ICA of all output changes. Finally, there's the Final stage when the simulation front-end unloads. This is when the simulation is saved to disk.

The different stages of creating a simulation, including the Visual Basic code involved, are presented below.

10

### ***Initial stage***

#### **1. Creating the ICA & the simulation engine objects**

##### Code:

Set moSimEngine = New classSimEngine

15

Set moICA = New classICA

Description: The first step in using the simulation engine is to create an instance of the class classSimEngine and also an instance of the class classICA. Note that the engine and ICA should be module level object "mo" variables.

20

#### **2. Loading the simulation**

##### Code:

lRet = moSimEngine.OpenSimulation(App.Path & DIR\_DATA &  
FILE\_SIMULATION, Me.bookSimulation)

25

lRet = moSimEngine.LoadSimulation(mlICATaskID, App.Path &  
DIR\_DATABASE & DB\_SIMULATION, 1)

Description: After the object creation, the OpenSimulation and LoadSimulation methods of the simulation engine object must be called. The OpenSimulation method reads the specified Excel 5.0 spreadsheet file into a spreadsheet control. The

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LoadSimulation method opens the simulation database and loads into memory a list of paths, a list of inputs, a list of outputs and a list of lists for the specific task. Every method of the simulation engine will return 0 if it completes successfully otherwise an appropriate error number is returned.

5

### 3. Initializing and loading the Intelligent Coaching Agent

#### Code:

```
lRet = moICA.Initialize(App.Path & "\" & App.EXENAME & ".ini", App.Path &  
DIR_DATABASE, App.Path & DIR_ICADOC, App.Path & "\")
```

10

```
lRet = moICA.LoadTask(mlICATaskID, ICASStudentStartNew)
```

Description: The simulation engine only works in conjunction with the ICA. The Initialize method of the ICA object reads the application .ini file and sets the

15 Tutor32.dll appropriately. The LoadTask method tells the ICA (Tutor32.dll) to load the .tut document associated to a specific task in memory. From that point on, the ICA can receive notifications.

Note: The .tut document contains all the element and feedback structure of a task.

20 Ex: SourcePages, SourceItems, TargetPages, Targets, etc...

### 4. Restoring the simulation

#### Code:

```
<<Code to reset the simulation when starting over>>
```

25 <<Code to load the controls on the simulation front-end>>

```
lRet = moSimEngine.RunInputs(sPaths, True)
```

```
lRet = moSimEngine.RunOutputs(sPaths, True)
```

```
lRet = moSimEngine.RunLists(sPaths, True)
```

```
Call moICA.Submit(0)
```

30 Call moICA.SetDirtyFlag(0, False)

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Description: Restoring the simulation involves many things:

- clearing all the inputs and lists when the user is starting over
- loading the interface with data from the simulation model
- invoking the RunInputs, RunOutputs and RunLists methods of the simulation engine object in order to bring the ICA to it's original state
- calling the Submit method of the ICA object with zero as argument to trigger all the rules
- calling the SetDirtyFlag of the ICA object with 0 and false as arguments in order to reset the user's session.

10

Running inputs involves going through the list of TutorAware inputs and notifying the ICA of the SourceItemID, TargetID and Attribute value of every input.

Running lists involves going through the list of TutorAware lists and notifying the ICA of the SourceItemID, TargetID and Attribute value of every item in every list.

- 15 The TargetID is unique for every item in a list.

Running outputs involves going through the list of TutorAware outputs and notifying the ICA of the SourceItemID, TargetID and Attribute value of every output.

20 ***Modification stage***

**1. Reading inputs & outputs**

Code:

Dim sdataArray(2) as string

Dim vAttribute as variant

- 25 Dim lSourceItemID as long

Dim lTargetID as long

lRet = moSimEngine.ReadReference("Distinct\_Input", vAttribute, lSourceItemID, lTargetID, sdataArray)

30

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Description: The ReadReference method of the simulation object will return the attribute value of the input or output referenced by name and optionally retrieve the SourceItemID, TargetID and related data. In the current example, the attribute value, the SourceItemID, the TargetID and 3 data cells will be retrieved for the input  
5 named Distinct\_Input.

## 2. Modifying distinct inputs

### Code:

```
Dim vAttribute as variant
10 Dim lSourceItemID as long
Dim sDataArray(2) as string

vAttribute=9999
sDataArray(0)="Data Cell #1"
15 sDataArray(1)="Data Cell #2"
sDataArray(2)="Data Cell #3"
lRet = moSimEngine.WriteReference("Distinct_Input", vAttribute, , sDataArray)
```

Description: Modifying a distinct input is as simple as calling the WriteReference  
20 method of the simulation object passing the input name, the new attribute value and optionally a data array. The simulation engine takes care of notifying the ICA of the change.

## 3. Modifying drag&drop inputs

### 25 Code:

```
Dim vAttribute as variant
Dim lSourceItemID as long
Dim sDataArray(2) as string

30 lSourceItemID=1202
vAttribute=9999
```

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sdataArray(0)="Data Cell #1"  
sdataArray(1)="Data Cell #2"  
sdataArray(2)="Data Cell #3"  
lRet = moSimEngine.WriteReference("DragDrop\_Input", vAttribute,  
5 lSourceItemID, sdataArray)

Description: Modifying a drag&drop input is as simple as calling the  
WriteReference method of the simulation object passing the input name, the new  
attribute value, the new SourceItemID and optionally a data array. The simulation  
10 engine takes care of notifying the ICA of the change.

#### 4. Reading lists

Code:

lRet = moSimEngine.ListRead(sListName, lListIndex, vAttribute, lSourceItemID,  
15 lTargetID, sdataArray)

Description: All list in the simulation model can be read one item at a time using the  
ListRead method of the simulation engine object. Passing the list name and the  
index of the item to retrieve, the function will return the Attribute value and  
20 optionally the SourceItemID, TargetID and data array of the item specified. Use a  
looping structure to read entire lists into memory, or to search for and retrieve a  
particular line item. This will be done quite often as designers generally allow users  
to manipulate items from lists. For example, if a user begins to drag an element of a  
list, you will need to retrieve this data from the list item they are dragging.

25

#### 5. Modifying lists

Code:

lRet = moSimEngine.ListAdd(sListName, vAttribute, lSourceItemID, sdataArray)  
lRet = moSimEngine.ListCount(sListName, lTotalItems)  
30 lRet = moSimEngine.ListModify(sListName, lListIndex, vAttribute, lSourceItemID,  
sdataArray)

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lRet = moSimEngine.ListDelete(sListName, lListIndex)

Description: The simulation engine object provides basic functionality to manipulate lists.

5

The ListAdd method appends an item(SourceItemID, Attribute, Data array) to the list. Let's explain the algorithm. First, we find the top of the list using the list name. Then, we seek the first blank cell underneath the top cell. Once the destination is determine, the data is written to the appropriate cells and the ICA is notified of the change.

10

The ListCount method returns the number of items in the specified list. The algorithm works exactly like the ListAdd method but returns the total number of items instead of inserting another element.

15

The ListModify method replaces the specified item with the provided data. Let's explain the algorithm. First, we find the top of the list using the list name. Second, we calculate the row offset based on the item number specified. Then, the ICA is notified of the removal of the existing item. Finally, the data related to the new item is written to the appropriate cells and the ICA is notified of the change.

20

The ListDelete method removes the specified item. The algorithm works exactly like the ListModify method but no new data is added and the cells (width of the list set by 'Total Columns') are deleted with the 'move cells up' parameter set to true. Keep this in mind, as designers often enter the wrong number of columns in the Total Columns parameter. When they overestimate the Total Columns, ListDelete will modify portions of the neighboring list, which leads to erratic behavior when that list is displayed.

25

### ***Feedback stage***

30

## **1. Running the simulation**

Code:

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lRet = moSimEngine.RunOutputs(sPaths, True)

Description: Inputs and lists notify the ICA when changes happen but not outputs. Therefore, the RunOutputs method must be invoked before submitting the work for feedback.

## 2. Triggering the ICA Rule engine

Code:

lRet= moICA.Submit(lCoachID)

Description: Once the simulation has been processed, the Submit method of the ICA object must be called to trigger all the rules and deliver the feedback. This feedback will be written by the Tutor32.dll to two RTF formatted files. One file for previous feedback and one file for the current feedback.

## 3. Displaying ICA feedback

Code:

Set oViewer = New CFeedbackViewer

oViewer.CoachID = vlCoachID

Call oViewer.DisplayFeedBack(moApp)

Description: The only thing required to display feedback information is to have an RTF control on a form and read-in the feedback files produced by the Submit method of the ICA object.

## *Final stage*

### 1. Saving the simulation

Code:

lRet = moSimEngine.SaveSimulation(App.Path & DIR\_DATA &  
FILE\_SIMULATION)

Description: The SaveSimulation method of the simulation engine object will save the specified Excel spreadsheet to disk.

## **SYSTEM DYNAMICS IN ACCORDANCE WITH A PREFERRED EMBODIMENT**

To use system dynamics models in the architecture, an engine had to be created that would translate student work into parameters for these models. A complex system dynamics model to interact with an existing simulation architecture is discussed below. The system dynamics model provides the following capabilities.

1. Allow designers to build and test their system dynamics models and ICA feedback before the real interface is built.
2. Reduce the programming complexity of the activities.
3. Centralize the interactions with the system dynamics models.

### **System Dynamics Engine**

As with the simulation engine, the designer models the task that he/she wants a student to accomplish using a Microsoft Excel spreadsheet. Here, however, the designer also creates a system dynamics model (described later). The system dynamics engine will read all of the significant cells within the simulation model (Excel) and pass these values to the system dynamics model and the ICA. After the system dynamics model runs the information, the output values are read by the engine and then passed to the simulation model and the ICA.

Figure 47 is a block diagram presenting the detailed architecture of a system dynamics model in accordance with a preferred embodiment. Once the simulation model, system dynamics model and feedback are completely tested by designers, developers can incorporate the spreadsheet in a graphical user interface, e.g., Visual Basic as a development platform. Figure 47 illustrates that when a student completes an activity, the values are passed to the system dynamics engine where the values are then passed to the system dynamics model (as an input), written to the simulation model and submitted to the ICA. When the system dynamics model is

played, the outputs are pulled by the engine and then passed to the simulation model and the ICA. Note that the simulation model can analyze the output from the system dynamics model and pass the results of this analysis to the ICA as well. The simulation model can then be read for the output values and used to update on-screen activity controls (such as graphs or reports).

It is very important that all modifications that the ICA and system dynamics model need to know about go through the engine because only the engine knows how to call these objects. This significantly reduces the skill level required from programmers, and greatly reduces the time required to program each task. In addition, the end-product is less prone to bugs, because the model and tutor management will be centralized. If there is a problem, only one section of code needs to be checked. Finally, since the engine loads the data from the spreadsheet, the chance of data inconsistency between the ICA, the system dynamics model and the application is insignificant.

Figure 48 is graphical representation of the object model which is utilized to instantiate the system dynamic engine in accordance with a preferred embodiment. The System Dynamics Object Model consists of a spreadsheet object, a system dynamics object, a simulation database, model objects, parameter input objects and parameter output objects. The first object in our discussion is the Spreadsheet object. The Spreadsheet is the support for all simulation models. The spreadsheet object is integrated with a Visual Basic development platform in accordance with a preferred embodiment. The control supports printing and is compatible with Microsoft Excel spreadsheets. With that in mind, designers can use the power of Excel formulas to build the simulation. These spreadsheets can sort or make calculations on the time interval data that is received from the system dynamics model, which allows the ability to show trends. This functionality allows a large amount of the calculations and number-crunching to occur in the spreadsheet and not in the code, placing more control with the activity designers.

The different cells in the spreadsheet model can be configured as parameter inputs or parameter outputs for a system dynamics model. This is what the system dynamics engine uses to write and read data from the system dynamics model, pass values to the ICA and update the student's work in the on-line activities. By making the spreadsheet object the central repository for the system dynamics data, we ensure that the system dynamics model, simulation model, activity and ICA are all in synch.

The system dynamics model generates simulation results over time, based on relationships between the parameters passed into it and other variables in the system. A system dynamics object is used to integrate with Visual Basic and the spreadsheet object. The object includes logic that controls the time periods as well as read and write parameters to the system dynamics model. With Visual Basic, we can pass these parameters to and from the model via the values in the simulation object.

The system dynamics object also controls the execution of the system dynamics model. What this means is that after all of the parameter inputs are passed to the system dynamics model, the engine can run the model to get the parameter outputs. The system dynamics object allows for the system dynamics models to execute one step at a time, all at once, or any fixed number of time periods.

When the system dynamics model runs, each step of the parameter input and parameter output data is written to a 'backup' sheet for two reasons. First, the range of data that is received over time (the model playing multiple times) can be used to create trend graphs or used to calculate statistical values. Second, the system dynamics model can be restarted and this audit trail of data can be transmitted into the model up to a specific point in time. What this means is that the engine can be used to play a simulation back in time.

When any event occurs within the system dynamics engine, a log is created that tells the designers what values are passed to the simulation model, system dynamics

model and ICA as well as the current time and the event that occurred. The log is called "SysDyn.log" and is created in the same location as the application using the engine. As with the spreadsheet object, the system dynamics object allows a large amount of the calculations to occur in the system dynamics model and not in the activity code, again placing more control with the activity designers.

Model objects are used to configure the system dynamics models with regard to the time periods played. Models are what the parameter inputs and parameter outputs (discussed later) relate to, so these must be created first. Every model has the

following application programming interface:

Field Name	Data Type	Description
ModelID	Long	Primary Key for the table
TaskID	Long	TaskID of the task associated with the model
ModelName	String*50	Name of the model (informational purposes)
ModelDesc	String*50	Description of the model (informational purposes)
SysDynModel	String*50	Filename of the actual system dynamics model
Start	Long	Start time to play modal
Stop	Long	Stop time to play model
Step	Long	Interval at which to play one model step and record data

This information is stored in the model table of the simulation database (ICASim.mdb). All of the values that will need to be manually entered by the student that are passed into the system dynamics model are configured as parameter inputs (PInputs) objects.

Every PInput has an interface as detailed below.

Field Name	Data Type	Description
PinputID	long	Primary Key for the table

TaskID	long	TaskID of the task associated with the parameter input
ModelID	long	ID of the model associated with the parameter input
InputName	string*50	Name of the parameter input (informational purposes)
InputDesc	string*255	Description (informational purposes)
ReferenceName	string*50	Name of the spreadsheet cell associated with the parameter input <sup>1</sup>
SimReferenceName	string*50	Name of the associated parameter in the system dynamics model
TutorAware	boolean	Whether the ICA should be notified of any changes to the parameter input
SourceItemID	long	SourceItemID of the parameter input
TargetID	long	TargetID of the parameter input
Row	long	Spreadsheet row number of the parameter input (used for speed optimization)
Column	long	Spreadsheet column number of the parameter input (used for speed optimization)
SheetName	string*50	Sheet name were the parameter input is located (used for speed optimization)

All of this information is stored for every parameter input in the PInput table of the simulation database (ICASim.mdb).

PInputs consist of one spreadsheet cell that can be populated by a designer at design time or by the GBS application at run time via the system dynamics engine object's methods. The purpose of the cell is to provide an entry point to the simulation and system dynamics models. An example of an entry point would be the interest rate parameter in the interest calculation example. The ICA is notified of any changes to the cell when an appropriate activity transpires. When the ICA is notified of a change two messages are sent to the ICA. The first is an ICANotifyDestroy message with the parameter input information i.e., SourceItemID, TargetID and null as an attribute. This message is sent to inform the ICA to remove information from its memory. The second message is an ICANotifyCreate message with the parameter input information i.e., SourceItemID, TargetID, Attribute (cell numeric value). This message advises the ICA to add this information to its memory.

To demonstrate the use of a parameter input, the interest rate calculation example is again used as a backdrop to illuminate various features. Figure 49 is a PInput Cell for a simulation model in accordance with a preferred embodiment. Figure 50 is a PInput backup cell in a simulation model in accordance with a preferred embodiment. Interest Rate is the parameter input for this model which will then be used to calculate balance and interest accumulations. A defined name will also have to be created for the backup of the PInput as each time interval is played. A requirement for this cell is that it has the same name as the original PInput, but also have the "\_BU" extension. The example here would be "Interest\_Rate\_BU." This cell will also have to be created in a column where no other data exists, since all of the backups are written below this cell. In the ICA, define a task that will be assigned to the simulation. For example, a TaskID of 123 is generated by the ICA. For this example, we will assume that we want to give feedback on the interest rate selected by the student. In the ICA, define a Target for the parameter input.

---

<sup>1</sup> PowerSim allows designers to create parameters as arrays. If this is the case, then each array item MUST have one parameter input. What this means is that dynamics arrays can not be used by the System Dynamics engine.

A PInput table record in accordance with a preferred embodiment is presented below.

PInputID:	12345
TaskID:	123
ModelID:	1
InputName:	Interest Rate input
InputDesc:	Interest Rate input into interest calculation model
ReferenceName:	Interest_Rate
SimReferenceName	Param_Interest_Rate
TutorAware:	True
SourceItemID	1201
TargetID:	4001
Row:	6
Column:	3
SheetName:	Sheet1

- Once the configuration is completed, the designer can also use the **ICA Utilities** to
- 5 test the simulation. The Row, Column and SheetName values are automatically populated when the designer runs the parameters in the System Dynamics Workbench in the **ICA Utilities**. The reason for obtaining the cell coordinates is that the processing of cell data is significantly faster with cell positions than simply using the defined name. The system dynamics engine decodes the defined name
- 10 (Reference Name) that the designer entered, and populates the table accordingly. This is an important step because there have been occasions when a designer would change the layout of a spreadsheet, i.e., move a defined name location, and then forget to perform this step. As such, bizarre data was being passed to the tutor; whatever data happened to reside in the old row and column. Cells in the
- 15 spreadsheet that are the output from a system dynamics models can be represented by parameter output objects (POutputs). Every POutput has an interface as detailed below.

Field Name	Data Type	Description
PoutputID	Long	Primary Key for the table
TaskID	Long	TaskID of the task associated with the parameter output
ModelID	Long	ID of the model associated with the parameter output
OutputName	String*50	Name of the parameter output (informational purposes)
OutputDesc	String*255	Description (informational purposes)
ReferenceName	String*50	Name of the spreadsheet cell associated with the parameter output
SimReferenceName	String*50	Name of the associated parameter in the system dynamics model
TutorAware	Boolean	Whether the ICA should be notified of any changes to the parameter output
SourceItemID	Long	SourceItemID of the parameter output
TargetID	Long	TargetID of the parameter output
Row	Long	Spreadsheet row number of the parameter output (used for speed optimization)
Column	Long	Spreadsheet column number of the parameter output (used for speed optimization)
SheetName	String*50	Sheet name were the parameter output is located (used for speed optimization)

- 5 All of this information is stored for every output in the Output table of the simulation database (ICASim.mdb). Each POutput object comprises a spreadsheet cell that is an output from the system dynamics model. This is the information that shows the student the results of their choices and is the main reason for using system dynamics. The POutput can be made TutorAware, which will notify the ICA of any changes to the cell when all the POutputs are processed otherwise the ICA will be

unaware of any changes. When the ICA is notified of a change, two messages are in fact sent to the ICA:

1. An ICANotifyDestroy message with the parameter output information i.e., SourceItemID, TargetID and null as Attribute. This message is to advise the ICA to  
5 remove this information from its memory.
2. An ICANotifyCreate message with the parameter output information i.e., SourceItemID, TargetID, Attribute (cell numeric value) . This message is to advise the ICA to add this information to its memory.

As opposed to PInputs which notify the ICA on every change, POutputs are  
10 processed in batch just before asking the ICA for feedback .

POutputs use is illuminated below by an example that builds on the previous interest calculation example. Here, we want to notify the ICA of the balance as it results from changes in the interest rate. Figure 51 is a display illustrating a POutput cell in  
15 accordance with a preferred embodiment. The steps required to configure the POutput are presented below.

1. Define a name for cell G4 in Excel. Here we have defined "Balance."
2. Define the name of the backup cell as "Balance\_BU" in a blank column.
- 20 3. Let's use the same TaskID as before since the Balance parameter is part of the same simulation as the Interest Rate parameter. Ex: TaskID is 123.
4. In the ICA, define a Target for the parameter output. Ex: a TargetID of 4005 is generated by the ICA.
5. In the ICA, define a SourceItem for the parameter output. Ex: a SourceItemID of  
25 1215 is generated by the ICA.
6. Associate the parameter output to a system dynamics model (refer to Model object discussion).
7. Add the information in the POutput table of the simulation engine database. This configuration can also be done within the ICA Utilities.

30 The record in the POutput table would look something like this:

OutputID:	12347
TaskID:	123
ModelID:	1234
OutputName:	Balance Value
OutputDesc:	Value of Balance after model has been run
ReferenceName:	Balance
SimReferenceName	Param_Balance
TutorAware:	True
SourceItemID	1215
TargetID:	4005
Row:	4
Column:	7
SheetName:	Sheet1

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The following information provides details describing the interaction components in accordance with a preferred embodiment.

Title	Description
Procedural tasks (w/drag drop)	Tasks which require the construction of some kind of report with evidence dragged and dropped to justify conclusions
Procedural tasks (w/o drag drop)	New task designs that are procedural in nature, have very little branching, and always have a correct answer.
Ding Dong task	Tasks that interrupt the student while working on something else. This template includes interviewing to determine the problem, and a simple checkbox form to decide how to respond to the situation.
Analyze and Decide (ANDIE) task	Most commonly used for static root cause analysis, or identification tasks. Developed on SBPC as a result of 3 projects of experience redesigning for the same skill.
Evaluate Options (ADVISE)	Used for tasks that require learner to evaluate how different options meet stated goals or requirements. Developed at SBPC after 4 projects experience redesigning for the same skill. Does not allow drag drop as evidence.
Run a company task	Time based simulation where student "chooses own adventure". Each period the student selects from a pre-determined list of actions to take. Developed on SBPC as a simplified version of the BDM manage task.
Use a model task	When user needs to interact with a quantitative model to perform what if analysis. May be used for dynamic root cause analysis - running tests on a part to analyze stress points.
ICA Dynamic Meeting Task	Developed on BDM to mimic interaction styles from Coach and ILS EPA. Supports dynamic-rule based branching - will scale to support interactions like EnCORE defense meetings and YES.

FIG. 4 is a diagram of a task design template.

Manage Task	Time based simulation where student manages resources. Human Resources Management, managing a budget, manage an FX portfolio.
QVID Static Meeting Task	Developed on Sim2 to support agenda-driven meetings where user is presented with up to 5 levels of follow-up questions to pursue a line of questioning. As they ask each question, it's follow-ups appear.
Flow Chart Task	Will support most VISIO diagrams. Developed on Sim2 to support simple flow chart decision models.
QVID Gather Data Component	Static flat list of questions to ask when interviewing someone. Not used when interviewing skills are being taught (use QVID Static meeting task). Supports hierarchical questions and timed transcripts.
Journalize Task	Created to support simple journal entry tasks with up to 2 accounts per debit or credit.
New Complex Task	A new task that requires a simulation component

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### Systems Dynamic Engine

The system dynamics engine is the interface between the simulation model, the system dynamics model, the simulation database and the Intelligent Coaching

- 5 Agent. The system dynamics engine is of interest to the designer so that she can understand the mechanics of it. Once the designer has constructed the simulation model (Excel Spreadsheet), built the system dynamics model (PowerSim) and configured all of the parameter inputs and parameter outputs, a test can be performed using the workbench included in the ICA Utilities (refer to ICA Utilities
- 10 documentation). The developers, in turn, need to implement the calls to the system dynamics engine in the GBS application that is being built. The following list identifies the files that need to be included in the Visual Basic project to use the system dynamics engine.

WSysDynEng.cls	System dynamics Engine class
wSysDynEng.bas	System dynamics Engine module (this module was introduced only for speed purposes because all the code should theoretically be encapsulated in the class)
wConst.bas	Intelligent Coaching Agent constant declaration
wDeclare.bas	Intelligent Coaching Agent DLL interface
wIca.cls	Intelligent Coaching Agent class
wIca.bas	Intelligent Coaching Agent module (this module was introduced only for speed purposes because all of the code should theoretically be encapsulated in the class)

15

To utilize the system dynamics engine fully, the developer must place code in different strategic areas or stages of the application.

- 1) Initial stage - the loading of the form containing the simulation front-end. This is when the simulation model and system dynamic engine are initialized.

2) Modification stage - Takes place when the user makes changes to the front-end that impacts the simulation model PInputs). This is when the ICA is notified of what's happening.

3) Run stage - The system dynamics model is run and parameter outputs are received.

4) Feedback stage - The user requests feedback on the work that they have performed. This is when the simulation notifies the ICA of all output changes.

5) Final stage - The simulation front-end unloads. This is when the simulation model is saved.

These stages will be explained by including the Visual Basic code involved as well as a short description of that code.

### Initial Stage Code In Accordance With A Preferred Embodiment

#### 1. Creating the ICA & the simulation engine objects

##### Code:

Set moSysDynEngine = New classSysDynEngine

Set moICA = New classICA

Description: The first step in using the system dynamics engine is to create an

instance of the classSysDynEngine class and also an instance of the classICA class.

Note that the engine and ICA should be module level object "mo" variables.

#### 2. Loading the simulation

##### Code:

lRet = moSysDynEngine.OpenSimulation(FILE\_SIM, Me.bookSim, True)

lRet = moSysDynEngine.LoadSysDyn(mlICATaskID, DB\_SIMULATION, 1)

lRet = moSysDynEngine.LoadModel(MODEL\_NAME,mbTaskStarted)

Description: After the object creation, the OpenSimulation, LoadSimulation and

LoadModel methods of the system dynamics engine object must be called. The

OpenSimulation method reads the specified Excel 5.0 spreadsheet file (FILE\_SIM)

- into a spreadsheet control (bookSim). The LoadSysDyn method opens the simulation database (DB\_SIMULATION) and loads into memory a list of parameter inputs and a list of parameter outputs. The LoadModel method opens a system dynamics model (MODEL\_NAME). Every method of the system dynamics engine
- 5 will return 0 if it completes successfully otherwise an appropriate error number is returned.

### 3. Initializing and loading the Intelligent Coaching Agent

#### Code:

- 10 lRet = moICA.Initialize(App.Path & "\" & App.EXENAME & ".ini", App.Path & DIR\_DATABASE, App.Path & DIR\_ICADOC, App.Path & "\" )

lRet = moICA.LoadTask(mlICATaskID, ICASStudentStartNew)

- 15 Description: The system dynamics engine only works in conjunction with the ICA. The Initialize method of the ICA object reads the application .ini file and sets the Tutor32.dll appropriately. The LoadTask method tells the ICA (Tutor32.dll) to load the .tut document associated to a specific task in memory. From that point on, the ICA can receive notifications.
- 20 Note: The .tut document contains all the element and feedback structure of a task. Ex: SourcePages, SourceItems, TargetPages, Targets, etc...

### 4. Restoring the simulation

#### Code:

- 25 lRet = moSysDynEngine.RunPInputs(MODEL\_NAME, True)  
lRet = moSysDynEngine.RunPOutputs(MODEL\_NAME, True)  
lRet = moSysDynEngine.PassPInputsAll  
Call moICA.Submit(0)  
Call moICA.SetDirtyFlag(0, False)

30

Description: Restoring the simulation involves many things:

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- clearing all of the parameter inputs and outputs when the user is starting over
  - loading the interface with data from the simulation model
  - invoking the PassPInputsAll method of the system dynamics engine object in order to bring the ICA to its original state
- 5
- invoking the RunPInputs and RunPOutputs methods of the system dynamics engine object in order to bring the system dynamics model to it's original state
  - calling the Submit method of the ICA object to trigger the ICA to play all of the rules
  - calling the SetDirtyFlag of the ICA object to reset the user's session.

10

Running parameters involves going through the list of TutorAware PInputs and POutputs and notifying the ICA of the SourceItemID, TargetID and Attribute value of every one.

15    Modification Stage

#### **1. Reading parameter inputs & outputs**

Code:

Dim sdataArray(2) as string

20    Dim vAttribute as variant

Dim lSourceItemID as long, lTargetID as long

lRet = moSysDynEngine.ReadReference("Input\_Name", vAttribute, lSourceItemID, lTargetID, sdataArray)

25

Description: The ReadReference method of the system dynamics object will return the attribute value of the parameter input or output referenced by name and optionally retrieve the SourceItemID, TargetID and related data. In the current example, the attribute value, the SourceItemID, the TargetID and 3 data cells will be

30    retrieved for the parameter input named Input\_Name.

## 2. Modifying parameter inputs

### Code:

```
Dim vAttribute as variant
Dim lSourceItemID as long
5 Dim sDataArray(2) as string
  vAttribute=9999
  sDataArray(0)="Data Cell #1"
  sDataArray(1)="Data Cell #2"
  sDataArray(2)="Data Cell #3"
10 lRet = moSysDynEngine.WriteReference("Input_Name", vAttribute, , sDataArray)
```

Description: To modify a parameter input, call the WriteReference method of the system dynamics object and pass the PInput reference name, the new attribute value and optionally a data array (an additional information to store in the simulation model). The system dynamics engine notifies the ICA of the change.

## Run Stage

### 1. Playing the System Dynamics Model

#### 20 Code:

```
lRet = moSysDynEngine.PlayModel(SYSDYN_PLAYSTEP)
lblCurrentTime.Caption = moSysDynEngine.CurrentTime
lblLastTime.Caption = moSysDynEngine.LastTime
```

25 Description: Playing the system dynamics model is also handled by the system dynamics engine. There are three ways that the models can be played, all at once, one step at a time (shown above) or until a specific point in time. These are the parameters that are passed into the PlayModel method. Playing of the model generates the parameter output values and passes the Tutor Aware POutputs to the

30 ICAT. The engine also keeps track of time and these values can be read using the CurrentTime and LastTime properties.

## 2. Jumping Back in a System Dynamics Model

### Code:

lRet = moICA.LoadTask(mlICATaskID, ICASStudentStartNew)

5 lRet = moSysDynEngine.JumpBack(TIME\_TO\_JUMP\_TO)

Description: Because the system dynamics engine writes backup copies of the parameters passed to and from it, it can start over and resubmit these values back to the system dynamics model until a given period of time. To do this, the code would

10 need to restart the ICA and then call the system dynamics engine to jump back to a given time (TIME\_TO\_JUMP\_TO).

### Feedback stage

## 1. Triggering the ICA Rule engine

### Code:

15 lRet= moICA.Submit(lCoachID)

Description: Once the simulation has been processed, the Submit method of the ICA object must be called to trigger all the rules and deliver the feedback. This feedback will be written by the Tutor32.dll to two RTF formatted files. One file for previous

20 feedback and one file for the current feedback.

## 2. Displaying ICA feedback

### Code:

Set oViewer = New CFeedbackViewer

25 oViewer.CoachID = vlCoachID

Call oViewer.DisplayFeedBack(moApp)

Description: The only thing required to display feedback information is to have an RTF control on a form and read-in the feedback files produced by the Submit

30 method of the ICA object.

## Final stage

### 1. Saving the simulation model

#### Code:

```
lRet = moSysDynEngine.SaveSimulation(FILE_SIMULATION)
```

5

Description: The SaveSimulation method of the system dynamics engine will save the specified Excel spreadsheet to disk.

Source Items and Targets relate to specific on-line objects. When these objects are selected in an activity, an associated Source Item and Target are 'mapped' into an ICA, which then looks at all of the configured rules and displays an appropriate feedback (known in the ICA as a Coach Item). For example, if an activity required users to drag an account name (Source Item) to a Journal Entry (Target), the ICA would be notified of this association and feedback would be delivered based on a set of predefined rules.

Feedback (Coach Items) can be displayed in two ways, as a parent or as a child. Parent feedback can be Stand Alone text where it is the only piece of feedback delivered, or it can be used as a header which will support many 'children' pieces of feedback. An example of a Parent header would be feedback that stated "Look at your Journal Entries, here is what I see..." Below this would be multiple line items that relate to specific feedback given to the student about a Journal Entry.

This structure will be used for the on-line meetings as well. Instead of the association of Source Items and Targets occurring when an item is dragged, it occurs when a question is selected by the student. Rules will be configured based on these mappings to fire specific feedback. The Parent header, instead of being text, will include video information such as the video to be played. The children feedback includes all associated follow-up questions.

30

## ICA Configuration in Accordance with a Preferred Embodiment

Figure 52 is an overview diagram of the logic utilized for initial configuration in accordance with a preferred embodiment. Since the structure of the feedback is the same as other on-line activities, the ICA can also be configured in the same manner. For ease of creation and maintenance of ICA feedback, it is recommended that the

5 feedback is constructed so that only one rule fires at any point in time. Note that the organization of the example is one of many ways to structure the feedback.

***Step 1: Create a map of questions and follow-up questions***

Before designers start configuring the ICA, they should draw a map of the questions, videos and follow-up questions that they wish to use in the on-line meeting. This

10 will give them a good understanding of the interactions as they configure the ICA.

***Step 2: Create a coach***

All feedback is given by a coach. Create a specific coach for the on-line meeting.

***Step 3: Create the Source Items and Targets***

Figure 53 is a display of the source item and target configuration in accordance with

15 a preferred embodiment. Every question will have one Source Item (1) and Target (2) associated with it. These will be used by the ICA to show videos and follow-up questions. For organizational purposes and ease of reading, it is recommended that each Source Page ("0 Intro") contain all of the follow up questions ("Intro Q1", "Intro Q2", "Intro Q3"). Targets can be created one per Source Item (shown here) or

20 one per many Source Items. This is not very important, so long as there are distinct Source Item and Target associations. Once the Source Items and Targets have been created, associate them into SourceItemTargets (3) and give them a relevance of one. These are the unique identifiers which the ICA will use to fire rules and to provide feedback to the student.

25 ***Step 4: Create the Parent Header (Video Information)***

Figure 54 is a display of video information in accordance with a preferred embodiment. Feedback (Coach Items) are organized into Target Groups (1). In Figure 54, each on-line question has one Target Group for ease of maintenance.

Each TargetGroup must have at least one related Target (4). These are the SourceItemTarget mappings that were made at the end of Step 3. Next, Rules (2) are created to fire when the SourceItemTarget is mapped (a question is clicked). Coach Items (3) are associated to a rule and represent the feedback which will be shown if the rule is fired.

Figure 55 illustrates a display depicting configured rules in accordance with a preferred embodiment. Rules are configured to fire when specific Source Items and Targets are mapped (when a user clicks on a question). For this reason, Aggregate Rules are configured that only look to see if this mapping has occurred. To have the rules query these mappings, the Target Group field (1) is equated to the Target that was mapped to this Target Group. For the rule to fire, special criteria have to be satisfied. The Source Item and Target are assigned a relevance of one so they will be recognized as a correct mapping (or UCP). Therefore, this rule fires if there is a minimum of one correct mapping, or UCP (2). Using this format, only one rule will fire at any point in time because only one question will be selected at any point in time.

Figure 56 illustrates feedback for configured rules in accordance with a preferred embodiment. Each rule has associated feedback (Coach Items) that depict when a rule is fired. To configure this feedback as a header, this Coach Item must be configured as a parent (1). Since this Coach Item is a header and will show other children feedback, the number of children displayed must also be set (2). This will be the number of follow up questions for the selected question. The feedback window is where the header text is configured relating the video information that will appear as a result of a question being selected (the SourceItem and Target mapping).

To separate the video information, the feedback text includes specific tags. To state the filename for the video played, the name must be inside the <F> and </F> tags. The start time for the video to play uses the <I> and </I> tags and the stop time uses

### ***Step 5: Create the Children (Follow-Up Questions)***

Figure 57 illustrates a display with follow-up configuration questions in accordance with a preferred embodiment. To configure the follow-up questions, each follow-up question is defined as a child in the same target group as the header. Remember that the header here was configured to have three children and there are also three follow-up question children configured. Each child also has one Rule and Coach Item associated with it.

Figure 58 illustrates configuration of aggregate rules in accordance with a preferred embodiment. The Aggregate Rules for the children are configured exactly the same as the parent header. Notice that the Target Group Target is the same Target as the parent. The Rule is also firing when this Target Group has a positive mapping (UCP of one). These rules are created in the same way so that the parents and children all fire at the same time.

20 Figure 59 illustrates a set of coach items in accordance with a preferred embodiment. The Coach Items for the children represent the follow-up questions. The coach items must be configured as children (1) so that they are properly associated with their respective parent. The feedback text (2) is the caption for the follow-up question.

25

Once the ICA configuration is complete, there is one last step to the process. In order for the selection of a question to drive other questions and videos, each question must relate to one Source Item and one Target. This way, when any

30 question is selected, the ICA is notified and the next video and group of follow-up questions can be displayed. In the ICA Utilities Suite, in accordance with a

preferred embodiment, there is an ICAMeeting Configuration tool which maps the individual Coach Items (Questions) to a Source Item and a Target. The Coach Item ID to be entered is the question that is selected by the user and the Source Item and Targets entered relate to the Target Group Targets that drive the video and follow up questions.

Figure 60 is an ICA Meeting Configuration tool display in accordance with a preferred embodiment. To add a new association, click on the Add New button on the toolbar (1). Here, designers can type the Coach Item, Source Item or Target Ids to associate. Another utility, the Object Viewer, can be used, which will display all of the relevant Coach Items, Source Items and Targets. These can then be dragged to the respective fields. All of the associations can be viewed from the grid depicted on the left side of the utility (2) in Figure 60.

### Using the ICAMeeting in Visual Basic

Once the ICAMeeting has been configured, it can be implemented or tested using Visual Basic. This would represent the on-line questions and videos that are driven by the ICA feedback. Below are the steps required to perform this action. In order to use the ICAMeeting in Visual Basic, the xICAMeeting.cls and xICAMeeting.bas files are required. Note that the Visual Basic components required for the ICA (wICA.cls, wICA.bas, wConst.bas, wDeclare.bas) are also required for the ICAMeeting class to work.

#### *Step 1: Create the controls needed for the ICA meeting*

- Create a command button as a control array for the questions
- Create a picturebox for the video to play
- Create a RichTextbox control to receive the ICA feedback
- Create a textbox for the transcripts of the video to appear

#### *Step 2: Configure the ICA Meeting*

- Initialize class

*Set moICAMeeting = New classICAMeeting*

- Configure parameters:

Set coachID to the ID created in the ICA for the coach

*moICAMeeting.CoachID = 4*

5

State if videos should show the control box to play and stop videos

*moICAMeeting.ShowClip = True*

Initialize class and pass in Question Button, Rich text control, Video

10

picturebox and Transcript text field

*Call moICAMeeting.Initialize(cmdQuestion(), rtxtHeader, picVideo, txtTranscript)*

- Set Question Click Event and pass in index of control array button clicked

15

*Call moICAMeeting.OnQuestionClick(Index)*

- Set Restart method (if desired) and pass in the ID of the task as configured in the ICA

*Call moICAMeeting.RestartMeeting(mlICATaskID)*

20

### Debugging

When debugging the on-line meeting, check that the following requirements exist.

If any of these criteria are not met, the meeting will not work properly.

### Target Groups

25

#### Target Groups

- Must have a Target that relates to a Source Item and Target Mapping




- Should contain the header and a few children

### Parent Coach Items (Video Information)

#### Rules

- Must use the coach defined for the activity

#### 5 Aggregate Rule

- Must have the Target that was assigned to the Target Group ()
- Must have a UCP minimum of 1

#### Coach Items

- Must be designated as a parent
- Must contain at least one child
- Feedback must be configured using the <F>,<I>,<O> and <T> tags


10

### Children Coach Items (Follow Up Questions)

#### Rules

- 15 • Must use the coach defined for the activity

#### Aggregate Rule

- Must have the Target that was assigned to the Target Group ()
- Must have a UCP minimum of 1

#### Coach Items

- 20 • Must be designated as a child
- Feedback must include text for a follow up question

### Intelligent Coaching Agent (ICA) Utilities

- The Intelligent Coaching Agent Tool (also known as the tutor) was used to create
- 25 remediation for the activities within the course and the architecture passed values to

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the tutor. One drawback was that the architecture did all of the processing and, therefore, all of the simulation. This was not the most data driven or most efficient way of creating business simulation because any changes to activities had to be made within code.

5

The ICA Utilities incorporate business simulation into a multimedia application. What this means is that there is now a middle layer between the application and the ICAT. These utilities, along with the simulation engine (described later), allow the architecture to be a front end to the simulation. Now, any changes to a simulation model do not need to be incorporated into code.

10

The ICA Utilities and simulation engine work with simulation models created in Microsoft Excel. After the model is created, the designer uses the Defined Name function in Excel to flag specific cells that are to be used by the application and the ICA Utilities in accordance with a preferred embodiment. Figure 62 illustrates an ICA utility in accordance with a preferred embodiment. The ICA Utilities consist of six utilities that work with the Intelligent Coaching Agent Tool (ICAT) to incorporate business simulation with the multimedia application. Below is a description of each utility, which will be discussed in detail following this introduction.

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20

- The Object Editor is used for the configuration of objects that translate simulation variables into values passed to the ICAT. This is really where the “middle layer” of the simulation is configured.
- The Simulation Workbench allows designers to test their spreadsheets once they have configured the simulation. Therefore, the testing of feedback can start well before testing, or even before any code is written at all!
- The Object Viewer is a tool that shows the designer the ICAT objects. This can be used for viewing purposes without using the ICAT.
- The Log Viewer shows all of the logs associated with the ICAT. This is helpful in debugging feedback received in the Simulation Workbench.

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- The ICA Doc Maker also designers to create TutorDoc files. These are the final outputs of the ICAT, which are used by the application to remediate.
- The Feedback Reviewer utility allows designers to resubmit previously submitted work to the ICAT.

5 Navigation:

Figure 62 illustrates a configuration utility display in accordance with a preferred embodiment. When first entering the Utilities, a user must select their user name (1) and the Task they wish to work on (2). User names can be added in the Object Editor (discussed later). Some of the utilities require user names to be selected and will not open without them. To open any of the ICA Utilities, users select the utility from a toolbar (3), or use the Utilities menu item which is accessible from any screen. Depending on which utility is open, other menu options become available. Because the ICA Utilities have six different utilities that can be opened at one time, these windows can be arranged for ease in viewing. The **Window** menu item, which is accessible from any screen allows multiple windows to be cascaded, tiled horizontally or tiled vertically.

At the bottom of the ICA Utilities, there is a status bar that relays information to the user. When the mouse is moved over key items in the utilities, such as the toolbar icons or utility buttons a description of what these objects do appears on this status bar. The status bar also displays information when processing is occurring as to what the utility is currently doing.



The Object Editor:

The Object Editor is used to translate application information into values for the ICAT, which can then be remediated upon.

Figure 63 illustrates an object editor toolbar in accordance with a preferred embodiment. The Object Editor uses this toolbar on the side of each configuration display. To add a new object, the Add New button is selected. To edit an existing

object, highlight that object and click on the **Edit** button. To delete an existing object, highlight the object and click the **Delete** button. When an object is being added or edited, the **OK** and **Cancel** buttons become enabled. To save changes, the **OK** button is selected and to cancel any changes, the **Cancel** button is selected.

- 5 Objects are scrolled by using the arrow buttons on the bottom of the toolbar. There is also a counter that displays the current record and how many total records are currently defined.

Figure 64 illustrates the seven areas that can be configured for a simulation in accordance with a preferred embodiment.

10



Paths are used to pass select information to the ICAT. If specific data needs to be passed to one coach (the ICAT allows for multiple team members to give feedback), while other data needs to be passed to a different coach, two Paths can be used to allow all of the data to be stored in one simulation model.

- 15 Figure 64 illustrates a display that defines inputs in accordance with a preferred embodiment.



Inputs are configured for the contributions in a simulation model. Using a model of  $a + b = c$ , "a" and "b" would be inputs. To configure an input, a name and description are given for informational purposes. A reference must also be provided. This is the Defined Name on the simulation spreadsheet where the input value resides. This reference is used by the Simulation Engine to locate the sheet and cell location of the input. Note that the Simulation Workbench can configure and view these defined names. These defined names can be typed in or dragged from the Simulation Workbench utility. A path must also be selected for an input. This is where a designer can be selective as to what information to pass to a coach in the ICAT. Because of this, at least one path must be created before an input can be properly configured.

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25

Inputs can also be used by the application, but not passed to the ICAT. To pass objects to the ICAT, a designer must specify the awareness of the Input tutor of the input. If the Input is to be passed to the ICAT, then a TargetID must be given to this input. Here is where the Object Viewer can be used. Target Ids can be typed in or  
5 dragged from the Object Viewer. SourceItemIDs can also be configured here. This should only be done if the Input has only one choice (such as a textbox). Multiple choices, such as a combobox or option buttons, allow for multiple SourceItemIDs and therefore, in those cases, this field should be left blank. Outputs are configured for outputs in the simulation model. Using the same example as above ( $a + b = c$ ),  
10 "c" would be the output. Outputs are derived from inputs into a model. Outputs are configured exactly the same as inputs.

Figure 66 illustrates a list editor in accordance with a preferred embodiment.



Lists are used to pass multiple objects to the ICAT. This is useful when there  
15 are many items to be passed to the tutor that are not static. For example, a drag-drop area where any number of items can be dragged over can be configured as a List. Dragging points over would add to the list, and dragging points off would delete from the list (and the ICAT). To configure a list, the designer must use multiple  
20 columns in the simulation model and no other information can be used in these columns. This is because when a list deletes an item, it shifts up all other cells below it. The defined name for the list is the first row where the first value resides. Lists also use the Name, Description, Reference and Path fields. Note that lists can also be Tutor Aware and must be assigned to a target. The one field used by a list that is different than an input or an output is the Total Columns field. This process  
25 defines how many columns are used by the list, including the defined name of the list.



Students are configured for the ICA Utilities. Figure 67A illustrates a define student display in accordance with a preferred embodiment. Students are the

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designers of the simulation models. A student must be selected before the other utilities can be used. Therefore, adding students should be the first task when using the utilities. Student name and description are used for informational purposes. The student ID is an identifier for the user and can be any number.

5



ControlSourceItems are SourceItemID values that can be stored to be used by the application. Figure 67B illustrates a ControlSourceItem display in accordance with a preferred embodiment. SourceItemIDs are Ids that the application must pass to the simulation engine, which then passes them to the ICAT. A SourceItemID relates to one data object that is being remediated on, such as a text field of account number. Using ControlSourceItems, the SourceItemIDs no longer have to stay hard-coded in the application and can change without any effects on code.

10

ControlSourceItems can be configured for a combobox of all twelve months.

Therefore, the first item in the combobox can be January, the second can be

15

February and so on. When the user selects a month, the application uses the index of the combobox to find the ControlSourceItem and pass that to the simulation engine.

ControlSourceItems are configured using a name and description for informational purposes. Module Name refers to the task that these items reside in. These can be

20

used for logical groupings of ControlSourceItems. The Item number is an index used to distinguish between ControlSourceItems (for example, the combobox listindex property). The SourceItemID for that ControlSourceItem is also needed and can be dragged from the object editor.



25

ControlTargets are like ControlSourceItemIDs, but instead of storing SourceItemIDs they store TargetIDs. If a SourceItem is something that is dragged from, then a Target is something that is dragged to.



### The Simulation Workbench:

The Simulation Workbench is used by designers to test the feedback created in the ICAT. It can also be used to configure simulation models. Simulation models can be imported by using the **File** menu path and then **Open**. Figure 68 illustrates a simulation workbench in accordance with a preferred embodiment. Once a simulation model has been loaded, the designer can enter values into their inputs and outputs and test the feedback. Notice here that the example of  $1 + 2 = 3$  is used with 1 and 2 being configured as inputs and 3 an output.

- 10 When a cell with a defined name is highlighted (here it is call B6), the Defined Name appears in the Active Cell Name field (1). This defined name can be dragged from this field to the Object Editor for configuration purposes. To run a simulation, the utilities need to be started. Click on the **Start Over** button (2). At this time, all of the Paths associated with that task will populate the Path list (3). Also, any
- 15 coaches configured in the ICAT will populate as buttons on the bottom of the toolbar (5) with an associated path. To run a simulation, select the simulation and click on the **Run Simulation** button (4). By running the simulation, all of the defined inputs, outputs and lists are passed to the simulation engine which then passes the TutorAware objects to the ICAT. The remediation can now be viewed by clicking on
- 20 any of the coaches on the bottom of the toolbar (5). By utilizing a Simulation Workbench, a designer can change inputs and outputs to simulate what the application will do and see their feedback, without any code being written yet.



### The Object Viewer:

- The Object Viewer is a snapshot of the ICAT configuration. Although ICAT
- 25 objects, such as Targets and SourceItems cannot be configured in the object viewer, the utility is good for viewing the objects as feedback and is used in the Simulation Workbench. Figure 69 illustrates an object viewer in accordance with a preferred embodiment. As shown in Figure 69, the object viewer lists the SourcePages, Target Pages and Target Groups for a selected task. By examining further details
- 30 associated with these objects, designers can obtain specific information, such as

SourceItemID numbers and the values that are mapped as correct answers.

SourceItemIDs and TargetIDs can be dragged from the graphical hierarchy on the left to the Object Editor to configure Inputs, Outputs, Lists, ControlSourceItems and ControlTargets.

5

Figure 70 illustrates an Object Viewer Configuration in an **Utilities** menu in accordance with a preferred embodiment. The object viewer configuration display facilitates interactive user selection of ICAT objects to view in the Object Viewer. These selections are saved for the designer as their preferences so that the next time the user utilizes a utility, the preferences are utilized as the user's predefined settings.

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#### The Log Viewer:

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The Log Viewer utility is used to view the logs created by the ICAT. These are very helpful in debugging feedback. Figure 71 illustrates a log viewer in accordance with a preferred embodiment.

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- The Debug Log shows every object passed to the ICAT. If an account was dragged to a journal page, then the SourceItemID (account) and target (Journal page) are mapped with the attribute (amount journalized). If an object is deleted, it is also noted here.
- The General Log shows general ICAT data such as the Target Groups, Rules and feedback received.
- The Load Log shows the ICAT objects used when the ICAT was loaded.
- The Student Log groups ICAT data by Target Group and shows the number of correct, incorrect or extra items in that group. This log also shows every ICAT rule as well which ones have been fired and which ones have not.
- The Last Submission Log shows the feedback received from the last submission to ICAT.
- The Error Log shows any errors that were incurred by the ICAT.

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#### The Doc Maker:

The Doc maker is used to make ICA Docs, which are used by the application and the Simulation Workbench to process information and give remediation. Figure 72 illustrates a Doc Maker display in accordance with a preferred embodiment. To

- 5 create an ICA Doc, a user selects the database from where the ICAT data is stored. Then, select the Document Path where the ICA Doc will be created to. Finally, select the desired tasks and click on the Make Docs button.



#### The Feedback Reviewer:

- 10 The feedback reviewer utility is used after the configuration process is complete and other users are working with the application. The application stores all of the ICAT submissions in a student table, which can then be passed back to the ICAT after changes have been made. Figure 73 illustrates a Feedback Reviewer display in accordance with a preferred embodiment. A user first selects a saved student profile by positioning the cursor over and clicking the Student combobox (1). This action
- 15 invokes logic which then populates any tasks that the student performed in the Task list (2). By selecting a task, all of the submissions that the student performed populate the submission table (7).

- To view a submission, click on the submission in the submission table (7). This will
- 20 populate all of the Targets, SourceItems and Attributes submitted at that time in the submission data table (6). Also, any comments added by the tester in the application will appear in the Tester Comment Field (8) as well as the feedback received for that submission (9). To resubmit this data to the ICAT, click on the Load Archive button (3). This action loads the SourceItems, Targets and Attributes from the Submission
- 25 Data (6) into the ICAT. Then, this data can be replayed one step at a time by clicking the Replay button (5) or all of the data for all submissions can be replayed by clicking on the Replay All button (4). After this data is replayed, the Current Feedback field (11) is populated with the feedback received. Any comments can be added to the Fixer Comments field (10). This utility efficiently facilitates student
- 30 submissions transmission to the ICAT without recreating the work. ICAT rules can

be configured and then the submissions can be replayed to test the associated changes.

### Example in Accordance With A Preferred Embodiment

The following example is provided to step through the process for using the ICA

5 Utilities:

#### Objective:

The objective here is to create a task where users will journalize an invoice and receive feedback on their work.

10 **Step 1) Configure the ICAT:**

After planning the task, the designer should add all relevant information to the ICAT such as the SourceItems (Accounts), Targets (Invoices), Attributes (Amounts to Journalize) and any Rules they wish to create. For this example, the correct answer is created in the ICAT (Debit Machinery for \$1,000 and credit Accounts Payable for \$1,000) along with some basic rules and feedback.

15

#### Step 2) Create the Simulation Model:

The tables below represent the model for the example simulation.

Accounts	SourceItem
Accounts Payable	1
Accounts Receivable	2
Cash	3
Machiner y	4

Invoice 1

<b>Wills Machinery</b>  Two pressing machines were purchased on account for \$1,000.
--

	Account SID	Amount
Debit		DR_AMOU NT

Credit		CR_AMOU NT
--------	--	---------------

The three tabular displays appearing above show an invoice associated with the purchase of two machines on account. We also see the SourceItemIDs for the possible accounts (these were configured in the ICAT). In the simulation model, defined names were given for the Amount fields in both the Debit (DR\_AMOUNT) and Credit (CR\_AMOUNT) fields. The SourceItemID field is created to the left of the attribute field and the attribute field always has the defined name. This is because the simulation engine finds the Defined Name and gets the attribute from there. Then, it looks to the left of the defined name to find the SourceItemID.

### Step 3) Configure the Inputs, Outputs and Lists

For this example, only 2 inputs are needed and they are the debit and credit entry for the invoice. In the Object editor, create a path to be used to pass the inputs to the ICAT. Then, configure the inputs using the DR\_AMOUNT and CR\_AMOUNT defined names and the Target defined in the ICAT. Figure 74 is an object editor display that illustrates the use of references in accordance with a preferred embodiment. The reference is used in the defined name (DR\_AMOUNT), the Input is Tutor aware and will be mapped to TargetID 300 (created in the ICAT to distinguish the debit for this invoice). The credit input is created in the same way.

### Step 4) Test the Feedback in the Simulation Workbench

Designers can open the Simulation Workbench and load the model that was created in Step 2. Then, different SourceItemIDs for the accounts and the amounts can be changed in the model. During this time, designers can Load and Run the Simulation to see the feedback. One example entails the step of putting the Machinery SourceItemID (4) in the Debit SID field, 1,000 in the Debit Amount field, Accounts Payable SourceItemID (1) in the Credit SID field and 1,000 in the Credit Amount field to see if they get praise by the Coach.

### Step 5) View and debug errors

After submitting multiple times to the ICAT, a designer can view what was passed to the tutor by viewing the logs in the log viewer. If there was an error, such as the correct answers being put in but incorrect feedback showing, these logs would prove helpful in tracking down the problem. Designers can also look in the Object Viewer to see the actual ICAT configuration.

The combination of the Log Viewer and ICAT Viewer will help the designer in testing and finding any problems in their feedback.

### 10 Step 6) Making changes are fixing errors

Once the problems have been tracked down (Step 5), a designer can make the appropriate changes in the ICAT. From the ICA Doc Maker utility, a new ICA Doc can be made and then retested all over again.

### 15 Step 7) Building the task

After the task has been designed and feedback created, the coder can use the ControlSourceItem object in the Object Editor utility to map the SourceItemIDs to specific accounts. Therefore, when a user drags an account from the chart of accounts, the application retrieves that SourceItemID from the ControlSourceItem list and then passes it to the Simulation Model.

Figure 75 presents the detailed design of smart spreadsheets in accordance with a preferred embodiment. Processing commences at function block 7500 where the excel spreadsheet is designed to model to perform scenario planning for the application that the business simulation is targeted for. By way of example, a model for real estate that analyzes an own versus rent decision is utilized to convey features in accordance with a preferred embodiment. Function block 7510 illustrates the next step which entails associating drivers for specific analysis tasks that are used in the model. For example, the price of unit, down payment, tax rate, estimated appreciation, assessment, rent, annual rent increase, type of loan, and salary will each be utilized in evaluating an formulating the decision. Then, at function block

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7520, a loan amortization schedule is created to track the ten year equity growth, tax savings, portfolio value, net gain/loss schedules.

5 The next step entails designing the tutor approach. First, at function block 7530, the expert metrics are identified for home buying metrics. These include the ratio of a person's salary to their home loan payment + assessment, new payment/rent, five year gain, % down, scenario assumptions regarding market and real estate appreciation. Then, at function block 7540 the relative weights for each metric are established and the rule structures are established that identify an appropriate  
10 conclusion to reach. For example, praise would entail a message saying home is a good buy, polish would entail a message that the home may be a good buy, but several risks should be addressed, focus parent would entail a message that the home is not a good buy due to the following indicators, and list the indicators suggesting that the home is not a good buy. Finally, a redirect message would be: are you  
15 kidding, the inputs are entirely unrealistic.

Function block 7550 creates the focus child feedback based on a prioritization of key metrics such as the break even is too long, and the appreciation isn't high enough to justify the estimated foregone stock market appreciation, or there is not enough  
20 money down to grow equity in a short period of time. Finally, as function block 7560 suggests, the feedback is tested with sample scenario data and a user test model is created to capture user questions at interaction points of relevance, questions are attached to the tutor regression database, and the feedback is fixed and tested in the regression workbench.

25

### **An Example In Accordance With A Preferred Embodiment**

Complex business simulations are possible utilizing the business simulation tool set. Figure 76 illustrates an example of a simulation 7600 for the training of a telephone operator and telephone customer service staff.

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The simulation 7600 includes a ICAT evaluator and virtual director engine and feedback 7610, a knowledge base 7620, multiple entities 7630, and multiple tasks 7640 for a student to learn. Other elements 7650 may also be added to the simulation.

5

The ICAT evaluator and feedback 7610 includes a method to compare student responses to correct responses and provide individualized feedback to the student. The functionality of the ICAT evaluator and feedback 7610 is more fully described above.

10

The knowledge base 7620 includes data representing the correct methods and answers to tasks and a access interface for the student to utilize to search for information to assist the student's responses.

15

A portion of the multiple entities 7630 would represent customers or other customer service staff such as supervisors, schedulers, technical support personnel and other staff members. These entities may be generated through the simulation or may be directed by or represent other students simultaneously participating in the simulation.

20

A portion of the multiple tasks 7640 would include receiving customer calls, providing information, entering orders, forwarding customer calls to technical staff or to supervisors, and other tasks.

25 Simulation construction requires several steps:

- Determine the goal(s) of the simulation
- Determine the core knowledge required to complete the simulation goal(s)
- Determine the skill level of the students to be trained
- Build the simulation
- 30• Test the simulation
- Implement the simulation

FOI b7E b7D b7C b7B b7A

- Review and update the simulation

A telephone operator simulation is described to illustrate an embodiment of this process. Administrative functions such as title, links and relationship to other  
5 simulations are not included but are additional capabilities of the embodiment to increase the utility of each embodiment.

### **Goal of the simulation**

The goal of the simulation is to train new telephone operators in handling typical  
10 telephone and in-person inquiries from customers. Individual goals are built from collections of subordinate goals. Goals may be as simple as a single word, phrase or motion or other activity needed to accomplish the ultimate training goal.

### **Core knowledge**

15 The core knowledge requires several sections of information:

- Examples of types of questions to be asked by customers
- Preferred responses to these requests
- Examples of less than preferred responses
- Why those responses are preferred or less than preferred

20

### **Determine skill level of students**

In this example, the students will be limited to new hire, telephone operator trainee students. This simulation can also be utilized to train and evaluate experienced operators on basic skills. As the knowledge base is broadened, the skill level of the  
25 trainees can include even advanced telephone operators, supervisors, and any other personnel that interface with telephone operators or perform similar tasks.

### **Build the simulation**

A domain expert works with the ICAT to build a knowledge base of the core  
30 knowledge. In this example, the domain expert is an experienced telephone operator. Several different, experienced telephone operators may be utilized as

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domain experts. Each aspect of the core knowledge is input to the knowledge base by query by the ICAT and response by the domain expert.

5 The domain expert's interface may be a computer workstation 7700 as shown in Figure 77. The domain expert 7710 has a keyboard 7720, a display 7730, and a microphone 7740 and headset 7750 combination which is connected to a computer processor 7760 for entering information into the knowledge base. Other input devices such as a mouse, video camera, scanner and others may also be utilized. The input may be in the form of keyboard entry and/or audio and video recordings and other types of information.

10 Figure 78 illustrates multiple domain experts 7810, 7820, 7830, 7840, collaborating to "build" a simulation. The multiple domain experts 7810, 7820, 7830, 7840, are connected to a common computer processor 7850. The multiple domain experts 15 7810, 7820, 7830, 7840, may be local or remote and connected to the computer processor 7850. The connection to the computer processor 7850 may be via a local network connection, remote wide area network connection, the internet, satellite link or any other means possible.

20 The following is an example of how a new scenario or section of a simulation is built:

Domain expert selects a menu item: EDIT SIMULATION and selects an existing simulation from a list, or creates a new simulation. With the simulation open, the domain expert selects a menu item: EDIT SCENARIO and selects an existing 25 scenario from a list, or creates a new scenario. With the scenario open, the ICAT works with the domain expert to build the scenario through a series of prompts such as the following:

**Prompt**

**Response**

### Prompt

### Response

Please enter a question to begin the scenario.

Free text entry of a question leading toward completion of at least one of the goals of the simulation such as: "I would like to order a new phone line."

Please enter a response.

Free text entry of a response such as: "Hello, Thank you for calling California Bell Telephone, my name is <STUDENT\_N>, how may I help you today?"

What is the STATUS of this response?

Select PREFERRED / ACCEPTABLE / MARGINAL / UNACCEPTABLE / OTHER

If OTHER is selected: Please identify the STATUS of this response.

Free text entry of an additional STATUS type and means to rank the additional STATUS among the existing STATUS types.

Please identify a key term or feature of the response.

Free text entry such as "California Bell Telephone"

Please identify another key term or feature of the response or NA if there are no additional key terms or features for this response.

Field entry such as <STUDENT\_N>

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### Prompt

### Response

Repeat operation 6 until response = NA

Please enter a video presentation of this response or NA if there are no video presentations for this response.

A prerecorded video clip may be selected or NA selected

Repeat operation 8 until response = NA

Please enter an audio presentation of this response or NA if there are no audio presentations for this response.

A prerecorded audio clip may be selected or NA selected

Repeat operation 8 until response = NA

Please enter another response or NA if there are no additional responses to this question.

Free text entry of a response such as: "Hi, Thank you for calling California Bell Telephone, how may I help you today?" or NA selected

Repeat operations 2 through 12 until response = NA

Please enter a video presentation of this question or NA if there are no video presentations for this question.

A prerecorded video clip may be selected or NA selected

Repeat operation 14 until response = NA

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### Prompt

### Response

- |   |   |  |
|---|---|--|
| . | Please enter a audio presentation of this question or NA if there are no audio presentations for this question. | A prerecorded audio clip may be selected or NA selected  |
|   |   |  |
| . | Repeat operation 16 until response = NA   |  |
|   |   |  |
| . | Please enter another question or NA if there are no additional questions to this scenario.                      | Free text entry of a question such as: "I would like to move my phone service to a new address" or NA selected |
|   |   |  |
| . | Repeat operations 2 through 18 until response = NA  |  |

If NA is selected, the scenario and simulation are closed.

Through this example iterative process the simulation may be filled with many options such as several different questions and responses; a variety of media, text, audio, video, and others to convey the questions and record the responses. This example is narrowly constrained so as to be merely illustrative and not comprehensive. Additional question and response methods such as audio, video, animation and virtual reality (VR) may also be included.

10

### Test the simulation

To test the simulation, the domain expert logs into the simulation as a student. The simulation presents a basic telephone call by a customer and the domain expert would respond and review the feedback and progression of the simulation. If there are any errors the domain expert would then make the corrections.

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## Implement the simulation

- First the new trainee would be required to identify themselves to the simulation. This can include any number of fields of information so that the simulation can “identify” the user and the type of training the user has had. This information is stored in a “User Profile.” The simulation uses the user profile to begin a record or “User Indicia file” for the user. Other types of information that would be automatically stored in the user indicia file would include without limitation, past training performance, remedial training required, user preferences and help engine usage and results. Many other types of information may be stored in this indicia file so as to fully record the user’s use of the simulation.

20

The student responds 7910 to the call: Student: “Hi, may I help you”. The ICAT  
25 would capture the student’s response 7920. The student’s response 7910 may be by  
text entry, multiple choice on the student’s display screen, by audio response, video  
response, or any other method of responding.

If the student's response is audio, as in this example, then the ICAT may time the  
30 response if necessary, then use a voice recognition module to convert the audio to

text and then evaluate 7940 the response by comparing the response to acceptable responses in the knowledge base and finally provide feedback 7950 to the student.

- 5 An example of a student workstation 8000 is illustrated in Figure 80. The student workstation 8000 includes a keyboard 8010, a display 8020, and a microphone 8030 and headset 8040 combination which is connected to a computer processor 8050 for entering responses to the simulation. Other input devices such as a mouse, video camera, scanner and others may also be utilized. The input may be in the form of keyboard entry and/or audio and video recordings and other types of information.
- 10 The link 8060 to the computer processor simulation server 8050 may be via a local network connection, remote wide area network connection, the internet, satellite link or any other means possible.

Some possible examples of responses and feedback include:

15

STUDENT RESPONSE	STATUS	FEEDBACK
Hello, Thank you for calling California Bell Telephone, my name is June, how may I help you today?	Preferred	Minor feedback required such as a bright green "APPROVED" icon or a high point score appearing on Student's display screen
Hi, Thank you for calling California Bell Telephone, how may I help you today?	Acceptable	Minor feedback required such as a dark green "APPROVED" icon or a lower point score appearing on Student's display screen AND offering student the opportunity to query the knowledge base for the preferred response and to re-try the simulation

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STUDENT RESPONSE	STATUS	FEEDBACK
Response using the word "Hi" and leaving out Company name or student name.	Marginal	Major feedback required such as a momentarily interrupting the simulation, displaying and/or playing an audio recording of the preferred response and asking if the student would like to re-try the simulation. If a point scoring system is used, no points would be awarded
Responses shorter than 1000 milliseconds or longer than 3000 milliseconds	Unacceptable	Major feedback required such as a momentarily interrupting the simulation, displaying and/or playing an audio recording of the preferred response and requiring the student to re-try the simulation. If a point scoring system is used, no points would be awarded

Additional STATUS levels and additional possible responses and feedback can also be added.

- 5 The simulation continues with an audio recording of a customer heard in the student's headset.

Customer: "I would like to order a new phone line".

Student: "Is this for your home?"

ICAT captures and evaluates student response and provides feedback such as shown in the following possible examples:

STUDENT RESPONSE	STATUS	FEEDBACK
"Is this for your home?"	Preferred	Minor feedback required such as a bright green "APPROVED" icon or a high point score appearing on Student's display screen
"Is this for your home or your business?"	Acceptable	Minor feedback required such as a dark green "APPROVED" icon or a lower point score appearing on Student's display screen AND offering student the opportunity to query the knowledge base for the preferred response and to re-try the simulation
"Excuse me but I need to get my supervisor to assist me"	Unacceptable	Major feedback required such as a momentarily interrupting the simulation, displaying and/or playing an audio recording of the preferred response and requiring the student to re-try the simulation. If a point scoring system is used, no points would be awarded

## STUDENT RESPONSE

## STATUS

## FEEDBACK

Angrily shouts into the microphone:  
 "You called the wrong number!  
 Hang up and call 888 555-1234 to  
 place telephone service orders."  
 And then disconnects the customer.

Unacceptable

Major feedback required such as a momentarily interrupting the simulation, displaying and/or playing an audio recording of the preferred response, notifying the course director and requiring the student to re-try the simulation. If a point scoring system is used, no points would be awarded

- Feedback, similar to the questions and responses described above, may be delivered in various forms of multimedia including without limitation, text, audio, video, animation, virtual reality and real-time audio and video. The necessary feedback
- 5 required is calculated by a combination of factors such as student's overall progress through the simulation and various aspects of student's specific response to the question including: correctness as objectively compared to the prerecorded responses; voice volume, speed and stress levels; other aspects. A degree of correctness or a congruency factor is determined from these functions. External
- 10 evaluators can also evaluate any or all of these factors and other factors. The external evaluators or the ICAT without the external evaluators' assistance may then direct the feedback required. The combination of the ICAT and any external evaluators makes up a "virtual director engine." External evaluators can include domain experts and other inputs external to the simulation that can provide inputs to
- 15 the simulation.

After appropriate feedback and any remedial simulation is completed, the simulation continues. Student's next simulation will depend upon the student's individual success at completing the simulation thus far. If a student is progressing very well,

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## 10 Guide to the Knowledge Base

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(Additional selections may also be provided)

Figure 81 illustrates the flow of a student query 8110 in a telephone operator simulation 8100.

- 5     Selecting "Present Example" 8120 causes the knowledge base to search 8122 for the preferred example or target response of how to handle the current simulation the student is working through. Once the preferred response example is determined, the preferred response example is presented 8124 to the student. Figure 82 illustrates a multimedia presentation of a preferred example response 8200. The preferred
- 10    example response 8200 may include a video component 8210, a text component 8220, an audio component 8230, a example illustration 8240, and other components such as animation may also be included in the presentation of a preferred example response 8200.
- 15    Returning to Figure 81, selecting "Hint From Coach" 8130 causes the knowledge base to search 8132 for the next step of the preferred response. Once the next step of the preferred response is determined, the step is presented 8134 to the student.
- Selecting "Enter Query" 8140 causes the knowledge base to process the student
- 20    query 8142. The knowledge base searches 8144 for related subjects. Presents a list of related subjects 8146. Student chooses the related subject to review 8148. The related subject is presented 8149. This is a more user friendly method of accessing the knowledge base than a simple text query described above. Instead of simply looking to the text entry the student inputs, this more intelligent method also
- 25    includes "context" features to the search such as: evaluate the specific simulation the student is facing; the student's success with the simulation thus far; previous hints and feedback provided to this student; previous hints and feedback provided to other similarly situated students; previous queries by this student; previous queries by other similarly situated students; and many other factors that may be included.

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At the end of the presentation of the preferred example, the simulation reverts back to the same point where the student first selected “Present Example.”

### **Review and update the simulation**

As the training continues, the ICAT records the student's responses that are different than the responses recorded by the domain expert. At some later time, the ICAT  
5 reviews these responses with the domain expert so that the domain expert may assist the ICAT in properly classifying the responses as preferred, non-preferred, etc and properly provide feedback to student.

10 Since this process "learns" from new material from students, it is superior that previous computer based training processes. In addition the multiple methods and levels of feedback enable the ICAT to provide individualized feedback to each student.

15 The simulations may vary from very basic as described above to very complex with many levels and directions of training. Using the above example of telephone operator training, the first two comments, which are very basic, simple issues for a telephone operator to handle. If the student responses to these simulations were the preferred responses, the ICAT would direct that student down a more difficult task so as to continue to challenge the student.

20

### **Multiple Students**

Simulations may also include the facility for multiple students to participate simultaneously. Figure 83 illustrates multiple students 8310, 8320, 8330, connected to the simulation server 8340 via a local connection 8350, via a internet or wide area  
25 network (WAN) connection 8360, and a microwave satellite link 8370. Any other method of interconnecting computers could also be utilized.

Expanding upon the above telephone operator training example, the simulation might also include: two students as operators taking customer calls; a third student  
30 handling technical support calls and referrals from the first two students; a fourth student, a more experienced telephone operator receiving more advanced training, as

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a telephone operator-supervisor handling issues the other students were unqualified to handle. To add difficulty, a student may even fill in the role as a customer. Other roles for additional students may also be included.

- 5 Each of the students' responses would be processed similar to the individual student described above. The ICAT would use the inputs from the multiple students to determine the feedback, direction, and difficulty of the simulation for each student. The ICAT may include multiple students in a single simulation so that the students may interact or the ICAT may maintain each student in separate simulations for
- 10 individual training.

- Figure 84 is a block diagram of a system environment in accordance with a preferred embodiment. A server computer 84000 includes server system software such as a Lotus Domino Server, with various databases for schedules, email, discussion
- 15 centers, knowledge data and global directory information including users 84001. In addition, advanced collaboration support is provided including support for a virtual classroom 84010. The server 84000 includes support for an internet protocol network 84020 including a dialup access server 84100 that communicates through a telephone company switched network 84120 to a remote System Management
- 20 Environment (SME) 84200 to a remote computer 84220. This includes support for mobile devices such as palm pilots, two-way pagers, windows CE systems and wireless intelligent telephones. On-site SME 84250 is also supported from the IP network 84020. This support includes support for most Microsoft Windows 95/NT workstations such as those typically used for user desktop applications 84500. The
- 25 IP Network 84020 also provides firewall Virtual Packet Network (VPN) access 84300 through the Internet 84310 to other firewall VPN access 84320 for subscribed users 84400 to provide access to applications to all users 84500.

- Figure 85 is a block diagram of a virtual consulting channel in accordance with a
- 30 preferred embodiment. The virtual consulting channel is a subscription-based service offering used to deliver dynamic content and tools (business simulations,

presentations, diagnostic tools, etc.) brought together by a content aggregator to develop awareness, create / sustain relationships and provide premium services to a client base utilizing a dynamic publishing paradigm for continuous refreshment of knowledge. A professor, teacher or other consultant prepares content which can take the form of presentations, papers, homework assignments, web pages, simulations, tests, research assignments or reading assignments that are published as shown in function block 85110. The publisher 85110 dynamically publishes the material as shown in function block 85120 after assuring that all the material is present and converts the information for use in collaboration 85131, scheduling / calendaring 85132, knowledge repository 85133, virtual training 85134, virtual meetings / rooms 85135 or news / profile 85136. The information is published utilizing an interface 85140 to subscribed users 85150 and public users 85160. Public content and media information from the Internet 85170 can be dynamically published or obtained from a subscription base 85185 through the content development function 85180.

A critical element of any virtual consulting channel will be the services that it provides to its subscribers. The Virtual Delivery Channels represent the access points to the underlying services that are provided for within the channel. There is no limit to the type of virtual delivery channels that could exist and the beauty of a virtual channel is that new delivery channels can be added quite easily. Here are some examples of the type of virtual delivery channels that could be used.

**Collaboration** - would provide the ability to create a collaborative environment between the user and Subject Matter Expert (SME) or create peer-to-peer collaboration between other subscribers with similar issues.

**Scheduling / Calendaring** - would provide the ability to provide scheduled times (ie. Office Hours) for SMEs to interact with subscribers one-on-one or as a group, also to provide a calendar of events/activities which the subscriber would be interested in.

**Knowledge Repository** - would provide access to a knowledge repository of high-value content, such as: business simulations, presentations, pre-recorded training sessions, etc.

5 **Virtual Training** - would provide for delivering real-time, facilitated training sessions via the channel led by a channel SME delivered to many subscribers at one time.

**Virtual Meetings / Rooms** - would provide for a virtual meeting capability between the subscriber and a SME. This capability would also allow for a private room to be used as a work-in-process room for subscriber interactions with channel SMEs.

10 **Industry News** - would provide for a push channel of information that would be relevant and could be targeted to each subscriber based on their preferences. Obviously, channel news would also be intermingled with the industry news.

**Forums** - would provide for a meeting place between subscribers around hot topics of interest.

15 **Tools** - provide downloadable diagnostic tools (with virtual coaches) that could be used by the subscriber.

Figures 86 is a data structure entity relationship diagram for a virtual consulting environment in accordance with a preferred embodiment. The students data

20 structure 86000 encapsulates information about each student comprising name, address, telephone number, student identification and year in school. Each student in the student entity has zero to many student class schedules 86010 throughout the course of his tenure at school. By the same token, every class schedule belongs to a single student. Each student class schedule 86010 consists of zero to many classes

25 86030 and each class is a part of zero to many class schedules. Each instructor class schedule 86020 comprises zero to many classes and any single class 86030 is a part of zero to many instructor class schedules 86020. A class 86030 is an instance of a course 86100 offered at a unique time. Each course 86100 has zero to many classes 86030 associated with it. Each class 86030 comprises zero to many class materials

30 86040 and class materials can be a part of one to many classes 86030. Class materials comprise links 86050, readings 86060, tests 86070 and assignments 86080.

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An instructor class schedule **86020** belongs to one and only one instructor while an instructor can have zero to many instructor class schedules **86020**. Each instructor **86090** may be in charge of zero to many courses **86100** while each course **86100** may be coordinate by one to many instructors **86090**. The administration entity data structure **86110** contains information pertaining to the administrative personnel for the university.

Figures **87 – 96** are flowcharts of a virtual university system in accordance with a preferred embodiment. Processing commences at function block **87000** when a connection is made through the internet to a website associated with the virtual university such as www.vu.edu. A test is made at decision block **87010** to determine where the web traveler would like to venture. The first destination is the student union at decision block **87030**. If the student union is the destination then at function block **88000** the traveler enters the student union which is detailed in Figure **91**. If the traveler wants to utilize a bulletin board for various functions detailed in Figure **91**, then the bulletin board function is used at function block **88010**. Finally, if the traveler wants to conduct collaborations with other persons in the virtual university, then the collaboration function is utilized at function block **88020** and control is passed back to label A **87020**.

If a traveler entering the virtual university desires to use the library as detected at decision block **87040**, then the various resources comprising links, articles and whitepapers are presented in function block **87050**. Function block **87070** provides access to a librarian and function block **87080** provides access to collaboration for conversing with other virtual university travelers. A list of active virtual university active participants is provided to select collaborators from. Finally, control is passed back to label A **87020** for further travel through the virtual university. Detailed processing for the library is provided in Figure **92**.

A label DD **87060** is provided to gain access to the administrative offices through decision block **88030**. If administrative functions are desired, then course

registration is provided at function block 88050, a university directory is provided at function block 88060, a class locator is provided at function block 88070, an administrative help desk is provided at function block 88080, add/drop processing is provided at function block 88090, a career center is provided at function block 88100 and then processing is returned to label A 87020. Detailed processing for the administrative functions is provided in Figures 93 and 94.

Further destinations for travelers in the virtual university are provided through label B 88040 which traverses to Figure 89. In Figure 89, an instructor lookup function is provided at function block 89010. A label BB 89030 provides direct access to a professor's virtual office. Decision block 89020 searches for a particular instructor (professor) name, and if the name is found, then at function block 89040, the professor's virtual office is entered and if office hours are in effect, then a student can interact with the professor in a chat room. A Frequently Asked Questions (FAQ) is provided to assist students as shown in function block 89050. Function block 89060 provides old tests, function block 89070 provides classroom issues, function block 89080 provides classroom materials, 89090 provides class handouts, function blocks 89100 provides research topics, function block 89110 provides professor office hours, and function block 89120 provides homework assignments. Finally, at label A 87020, control is passed back for further travel through the virtual university.

If the traveler desires further class access as detected at decision block 89210, then function block 89230 provides a class directory. If class access is not desired at decision block 89210, then control is passed via label a 87020 for further travel through the virtual university. Function block 89240 provides class materials, function block 89250 provides access to a student's grades, function block 89260 provides access to class announcements, function block 89270 provides access to class homework, function block 89280 provides access to tests, function block 89290 provides access to class schedules, function block 89300 provides access to a breakout room, function block 89310 provides access to research topics and function

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block 89320 provides access to lectures. Finally, at label A 87020 control is passed back to provide further travel through the virtual university.

Figure 90 provides detailed logic on directory processing in accordance with a preferred embodiment. Processing commences at function block 90000 where a class directory is accessed to provide the location of a class at function block 90100, the time of the class at function block 90110, the date of the class at function block 90120 and entry to the class is provided via label CC 90010. From label CC 90010, control is passed to function block 90200 for student interaction. A label DD 90150 is provided to directly branch to student collaboration at function block 90140. Collaboration functions include e-mail to a student at function block 90160, voice or video mail at function block 90170, contact information at function block 90180 and finally a branch back via label AA 90190 to provide professor directory processing. Function block 90230 provides professor lookup via a branch to label BB 89030. Similarly, the administrative directory functions are provided via function block 90240 via a branch through label DD 90150. Finally, control is passed back to the calling function via return label 90260.

Figure 91 provides detailed logic associated with student union processing in accordance with a preferred embodiment. Label A 91000 is provided to allow direct access to a menu of options in function block 91010. Then, at decision block 91020, a test is performed to determine if bulletin board processing is desired. If so, then at function block 91030, a post to the bulletin board is provided to allow a traveler to post a new message. Function block 91040 allows a traveler to read a message, function block 91050 allows a traveler to respond to a bulletin board posting, function block 91060 allows a traveler to delete a bulletin board posting and function block 91070 allows a traveler to append to a bulletin board posting. Finally, via label A 91000 control is returned to the menu of options for further student union processing.

If student union collaboration is desired as determined in decision block 91100, then a list of active people is presented to the traveler at function block 91120 and selections are allowed at function block 91130 and a test is performed to determine if chat or collaboration are desired at decision block 91140. A label SU1 91110 is provided for direct entry to the collaboration function. Also, if no collaboration is desired, then at decision block 91150 a test is performed to determine if exit from the student union is desired. If so, then control is returned at label 91160. If not, then control is returned via label A 91000 to the menu of options. If collaboration or chat is not desired, then control is passed via label A 91000. Collaboration is enabled for video at function block 91170, for audio at function block 91180, for text at function block 91190, for whiteboard at function block 91200, for application sharing at function block 91210 and for internet browsing at function block 91220. Finally, control is passed via label A 91000 back to the menu of student union options.

Figure 92 presents the detailed logic for the virtual library in accordance with a preferred embodiment. A label L1 92000 is provided to facilitate library processing. At decision block 92010, a test is performed to determine what resources are desired. At function block 92020 a list of resources is presented and at function block 92030 a traveler is asked to select the desired resource. Function block 92040 allows a user to view the resource. Function block 92050 allows a user to print a resource. Function block 92060 allows a user to save a resource. Function block 92070 allows a user to e-mail a link to a particular resource to another user to allow the user access to the resource. Finally at label L1 92000, control is passed back to facilitate other library functions. At decision block 92080 a test is performed to determine if a virtual librarian is desired. If so, then resources are reserved at function block 92230 such as books, microfilm, articles and other library material. Then, at function block 92240 questions can be asked of the librarian and control is passed via label L1 92000 for further virtual library functions. Decision block 92100 determines if collaboration is desired. If so, then processing is passed via label SU1 91100 to process the collaboration. If not, then a test is performed at decision block 92210 to

determine if exit from the library is desired. If so, then control is returned at label 92220, and if not, then control is passed via label L1 92000 for further library processing.

- 5 Figure 93 and 94 provide detailed logic on administrative office functions in accordance with a preferred embodiment. Processing commences at label A01 93000 and an immediate test is performed at decision block 93100 to determine if course registration should commence. If so, then at label CR1 93110 function block 93120 allows a traveler to view courses and function block 93130 allows a user to
- 10 select a course and if a traveler decides at decision block 93140 to attempt registration, then the traveler can view the course details at function block 93150. If the course is full at decision block 93160, then control is passed back to function block 93120 to view other courses. If not, then the student is registered at function block 93170 and the student is billed at function block 93180. Then, control is
- 15 returned via label A01 93000 for further administrative office processing. If a university directory search is desired, then an entry is searched against the university database in function block 93310, function block 93320 provides a view of directory information of persons or entities. Function block 93330 provides a copy of information to a travelers personal directory and a test is performed at decision block
- 20 93340 to determine if a directory search for a student, professor or administrative function is needed. If so, then control is passed via DD1 90150. If not, then control is passed via label AO1 93000.

- If a class locator is desired at decision block 93210 then control is passed via label
- 25 CL1 89210 to locate the class. If a administrative help desk is desired, then function block 93350 provides answers to questions, and at function block 93360 Frequently Asked Questions (FAQ)s are answered. Then, a test is performed decision block 93370 to determine if collaboration is desired. If so, then control is passed via label SU1 91110 to determine the proper form of collaboration and perform the function.
- 30 If collaboration is not desired, then control is passed back via A01 93000 for further

Figure 94 provides additional detailed logic for administrative office in accordance

5 with a preferred embodiment. Control enters via label A02 94010 and a test is performed to determine if add / drop is desired. If so, then at function block 94000 the schedule can be viewed and at decision block 94100 an addition of the course is performed via label CR1 93110. If not, then if a drop is desired, then the course is removed at function block 94120 and the student's bill is updated at function block 10 94130 and control is passed via label A01 93000. If a career center review is desired as detected at decision block 94030, then at function block 94040 Frequently Asked Questions (FAQ)s are presented. Function block 94050 presents job postings for available positions, function block 94060 presents career research companies to provide assistance with jobs, function block 94070 presents signup information for 15 interviews and function block 94080 facilitates submission of a resume. Finally, at label A01 93000 control is returned for further administrative office processing.

Figure 95 presents the detailed logic associated with virtual classroom processing in accordance with a preferred embodiment. Processing commences at function block 95000 when a traveler enters the classroom. A list of students is presented in decision block 95010, then at function block 95020 a student can enter a chat room or at function block 95030 a student can enter a collaboration and control is returned to label A 95001. A test is performed at decision block 95040 to determine if a student desires to participate in a class. If so, then at function block 95050 a student can listen to a lecture, at function block 95060, a student can watch a video, at function block 95100 a student can watch a presentation, at function block 95110 a student can collaborate with a class, function block 95120 a virtual hand raise to be recognized for participation is handled, function block 95130 interactive browsing is performed, function block 95140 an assignment can be submitted and at function block 95150 a test can be taken and control is returned to label A 95001.

If instruction is desired as detected at decision block 95300, then a lecture can be presented in function block 95400, a presentation is displayed at function block 95410, a collaboration is initiated at function block 95420, a moderation is performed at function block 95500, breakout groups or rooms are initiated at  
5 function block 95600 and a session is recorded at 95610 and control is returned to label A 95001.

If lessons are to be created as detected at decision block 95310, then presentations are created in function block 95200, create videos in function block 95210, create  
10 links as in function block 95220, create a simulation in function block 95230, add materials to the resource center in function block 95240, create assignments in function block 95250 and create tasks in function block 95260 and control is returned to label A 95001. Then, via label g 95320 control is passed to a decision block to determine if the traveler desires entry into the resource center. At function  
15 block 96100 materials can be viewed, at function block 96110 past sessions can be viewed, at function block 96120 assignments can be viewed, at function block 96130 Frequently Asked Questions (FAQ)s can be reviewed, at function block 96140 assignments can be submitted, at function block 96150 past tests can be reviewed and at function block 96160 feedback can be submitted to the instructor. Finally,  
20 control is returned label 96200 or 96210.

Figure 97 is a flowchart presenting the detailed logic for virtual consulting in accordance with a preferred embodiment. The logic commences at decision block 97000 when a traveler decides whether to enter the virtual reception area. If entry is  
25 desired, then at function block 97010 a directory listing is obtained, from the directory listing, calls can be placed, e-mails, chatrooms entered, collaborations commenced as discussed above at label 90150 in Figure 90. Function block 97020 provides processing for questions directed to the receptionist and function block 97030 for collaboration processing as discussed in Figure 90. Function block 97040  
30 presents a list of meetings for scheduling purposes and to determine what meeting is appropriate to attend and to perform meeting management. Actions for meeting

management comprise attending a meeting, scheduling a meeting, rescheduling a meeting, canceling a meeting, invitations to meeting, add items for use in the meeting such as papers, presentations or simulations and reserving an appropriate room. Other meeting management functions include whether the meeting is a public or private meeting. If it is private only the invited attendees are allowed to attend the meeting. If it is public, then others can drop by and interrupt. A graphical user interface portrays the type of meeting utilizing an appropriate indicia such as color, label or graphical item. When meeting management is completed control is returned to label A 97001.

10 Decision block 97050 determines whether the traveler will attend a meeting. If so, then at function block 97060, a traveler can listen and view the material for the meeting, at function block 97070 a traveler can collaborate in a meeting, at function block 97080 a traveler can record a meeting to a server or the traveler's computer, at  
15 function block 97090 a traveler can see a list of other attendees to a meeting and control is returned to label A 97001.

A decision is made at decision block 97200 to decide if the traveler desires to enter into a project room, Then, at function block 97210 a user can view a listing of all the people that are active in the project and perform directory functions such as those discussed with reference to Figure 90. Function block 97220 allows a traveler to review artifacts such as project deliverables, presentations and other materials.  
20 Then, at function block 97230 a traveler can add artifacts, or edit artifacts as shown in function block 97240 and control is passed via label A 97001. An artifact can be  
25 deleted at function block 97250 and collaboration is performed at function block 97260 as detailed in Figure 90. Function block 97270 processes newsgroups such as threads associated with a topic of interest to the traveler and function block 97280 processes discussion groups such as an interactive chat session or collaboration concerning a point of interest with multiple participants. Finally control is returned  
30 via label A 97001.

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embodiment. A test 98000 determines if a virtual office is to be entered, if so, then at function block 98010, artifacts are processed in a manner similar to resource procesing as detailed in the library with reference to Figure 92. Collaboration is also provided in function block 98020 as detailed in Figure 90 and control is passed via label A 97001. A test 98030 is performed to determine if a traveler desires entry into a virtual lounge. If so, then functions such as bulletin board 98100, newsgroups 98110, discussion groups 98120, list of active people 98130 and collaborations 98140 are handled as described earlier with reference to the student union in Figure 87. Functions such as view 98150, add 98160, edit 98170 and delete 98180 are provided for the bulletin board, newsgroups and discussion groups. Then, control is returned via label A 97001.

The T.120 standard contains a series of communication and application protocols and services that provide support for real-time, multipoint data communications. These multipoint facilities are important building blocks for a whole new range of collaborative applications, including desktop data conferencing, multi-user applications, and multi-player gaming.

Broad in scope, T.120 is a comprehensive specification that solves several problems that have historically slowed market growth for applications of this nature. Perhaps most importantly, T.120 resolves complex technological issues in a manner that is acceptable to both the computing and telecommunications industries.

- 5 Established by the International Telecommunications Union (ITU), T.120 is a family of open standards that was defined by leading data communication practitioners in the industry. Over 100 key international vendors, including Apple, AT&T, British Telecom, Cisco Systems, Intel, MCI, Microsoft, and PictureTel, have committed to implementing T.120-based products and services.

10

While T.120 has emerged as a critical element in the data communications landscape, the only information that currently exists on the topic is a weighty and complicated set of standards documents. This primer bridges this information gap by summarizing T.120's major benefits, fundamental architectural elements, and core capabilities.

15

### **Key Benefits of T.120**

- So why all the excitement about T.120? The bottom line is that it provides exceptional benefits to end users, vendors, and developers tasked with implementing
- 20 real-time applications. The following list is a high-level overview of the major benefits associated with the T.120 standard:

#### **Multipoint Data Delivery**

- T.120 provides an elegant abstraction for developers to create and manage a
- 25 multipoint domain with ease. From an application perspective, data is seamlessly delivered to multiple parties in "realtime."

#### **Interoperability**

- T.120 allows endpoint applications from multiple vendors to interoperate. T.120 also
- 30 specifies how applications may interoperate with (or through) a variety of network bridging products and services that also support the T.120 standard.

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### **Reliable Data Delivery**

Error-corrected data delivery ensures that all endpoints will receive each data transmission.

5

### **Multicast Enabled Delivery**

In multicast enabled networks, T.120 can employ reliable (ordered, guaranteed) and unreliable delivery services. Unreliable data delivery is also available without multicast. By using multicast, the T.120 infrastructure reduces network congestion and improves performance for the end user. The T.120 infrastructure can use both unicast and multicast simultaneously, providing a flexible solution for mixed unicast and multicast networks. The Multicast Adaptation Protocol (MAP) is expected to be ratified in early 1998.

10

### **Network Transparency**

Applications are completely shielded from the underlying data transport mechanism being used. Whether the transport is a high-speed LAN or a simple dial-up modem, the application developer is only concerned with a single, consistent set of application services.

20

### **Platform Independence**

Because the T.120 standard is completely free from any platform dependencies, it will readily take advantage of the inevitable advances in computing technology. In fact, DataBeam's customers have already ported the T.120 source code easily from Windows to a variety of environments, including OS/2, MAC/OS, several versions of UNIX, and other proprietary real-time operating systems.

25

### **Network Independence**

The T.120 standard supports a broad range of transport options, including the Public Switched Telephone Networks (PSTN or POTS), Integrated Switched Digital Networks (ISDN), Packet Switched Digital Networks (PSDN), Circuit Switched

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Digital Networks (CSDN), and popular local area network protocols (such as TCP/IP and IPX via reference protocol). Furthermore, these vastly different network transports, operating at different speeds, can easily co-exist in the same multipoint conference.

5

### **Support for Varied Topologies**

Multipoint conferences can be set up with virtually no limitation on network topology. Star topologies, with a single Multipoint Control Unit (MCU) will be common early on. The standard also supports a wide variety of other topologies ranging from those with multiple, cascaded MCUs to topologies as simple as a daisy-chain. In complex multipoint conferences, topology may have a significant impact on efficiency and performance.

10

### **Application Independence**

Although the driving market force behind T.120 was teleconferencing, its designers purposely sought to satisfy a much broader range of application needs. Today, T.120 provides a generic, real-time communications facility that can be used by many different applications. These applications include interactive gaming, virtual reality and simulations, real-time subscription news feeds, and process control applications.

15  
20

### **Scalability**

T.120 is defined to be easily scalable from simple PC-based architectures to complex multi-processor environments characterized by their high performance. Resources for T.120 applications are plentiful, with practical limits imposed only by the confines of the specific platform running the software.

25

### **Co-existence with Other Standards**

T.120 was designed to work alone or within the larger context of other ITU standards, such as the H.32x family of video conferencing standards. T.120 also supports and cross-references other important ITU standards, such as V.series modems.

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### **Extendability**

- The T.120 standard can be freely extended to include a variety of new capabilities, such as support for new transport stacks (like ATM or Frame Relay), improved
- 5 security measures, and new application-level protocols.

### **Application-level Interoperability**

- The upper levels of T.120 specify protocols for common conferencing applications, such as shared whiteboarding and binary file transfer. Applications supporting these
- 10 protocols can interoperate with any other application that provides similar support, regardless of the vendor or platform used. This interoperability will exist in simple point-to-point conferences as well as large multipoint conferences using a conference bridge.
- 15 The H.323 standard provides a foundation for audio, video, and data communications across IP-based networks, including the Internet. By complying to H.323, multimedia products and applications from multiple vendors can interoperate, allowing users to communicate without concern for compatibility. H.323 will be the keystone for LAN-based products for consumer, business,
- 20 entertainment, and professional applications.

- H.323 is an umbrella recommendation from the International Telecommunications Union (ITU) that sets standards for multimedia communications over Local Area Networks (LANs) that do not provide a guaranteed Quality of Service (QoS). These
- 25 networks dominate today's corporate desktops and include packet-switched TCP/IP and IPX over Ethernet, Fast Ethernet and Token Ring network technologies. Therefore, the H.323 standards are important building blocks for a broad new range of collaborative, LAN-based applications for multimedia communications. The H.323 specification was approved in 1996 by the ITU's Study Group 16.
- 30 Version 2 was approved in January 1998. The standard is broad in scope and includes both stand-alone devices and embedded personal computer technology as well as point-to-point and multipoint conferences. H.323 also addresses call control,

multimedia management, and bandwidth management as well as interfaces between LANs and other networks.

Then, at function block 99020 the application for collaboration is selected for the  
5 two or more users. A user selects a mode of collaboration such as a chat room  
audio, video, application sharing or white boarding and if necessary selects the  
application to share. Then, at function block 99030, the application is initiated and  
the two or more users are synchronized to the collaborative session at function block  
99040 and the control is synchronized at function block 99050. Then, the two or  
10 more users collaborate until they are finished and exit at function block 99060.

A user interface for communicating the status of a person or other entity could  
include color to denote the status of the person. So for example, a person that was  
unavailable for a meeting could be denoted with an indicia denoting their status.  
15 This indicia could be a graphical character, for example a telephone to the ear of the  
party denoting they are on the telephone, or the color red to indicate they were not to  
be disturbed. One of ordinary skill in the art will readily comprehend that other  
indicia may be utilized to communicate effectively the current status of a person or  
other entity.

20 Agents in the form of software programs to perform specific actions on behalf of a  
user can be utilized to complete tasks such as scheduling appointments, identifying  
availability of persons, searching for resources or retrieving information. Mobile  
devices such as cellular phones, window CE devices and two-way pagers can also  
25 launch agents and perform other actions in the environment such as collaborations.  
A dashboard can be utilized to summarize real-time information for a user based  
upon a personal profile specified by a user and stored in a database. Summaries  
include e-mail, voicemail, calendars, todo lists, person status and personalized  
newsfeeds.

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While various embodiments have been described above, it should be understood that they have been presented by way of example only, and not limitation. Thus, the breadth and scope of a preferred embodiment should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance  
5 with the following claims and their equivalents.

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